AT-60 ECG and Spirometry Unit

Service Handbook

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AT-60 Service Handbook

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Associated Documents

Guide to SCHILLER Interpretation and Measurement Program E / D / F	Article No.	2. 510 179
SCHILLER AT-60 USER GUIDE - English	Article No.	2. 510 116
SCHILLER AT-60 USER GUIDE - German	Article No.	2. 510 115
SCHILLER AT-60 USER GUIDE - French	Article No.	2. 510 117

CE 0124 93/42/EEC Medical Devices: 0124
'Notified Body' DEKRA AG

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DECLARATION OF CONFORMITY

Diagnostic System :	**Cardiovit AT-60**
Serial numbers starting with:	040.
Year of manufacture:	1997 Onwards

We, the undersigned, hereby declare that the medical device (class IIa) specified above conforms with the essential requirement listed in Annex 1 of EC Directive 93/42/EEC.

This declaration is supported by:

Certificate of approval No.:	11425-01	ISO 9001 (REV. 1994) EN 46001 by SQS
	45112-60-01	ISO 9001/08.94 EN 46001 / 12.93 by DEKRA and
	45112-16-01	Annex II, Section 3 of the directive 93/42/EEC

CE 0124

Baar (Switzerland) Dated 30.06.1998

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Warranty

Disclaimer

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Terms of Warranty

The SCHILLER AT-60 is warranted against defects in material and manufacture for the duration of one year (as from date of purchase). Excluded from this guarantee is damage caused by an accident or as a result of improper handling. The warranty entitles free replacement of the defective part. Any liability for subsequent damage is excluded. The warranty is void if unauthorized or unqualified persons attempt to make repairs.

In case of a defect, send the apparatus to your dealer or directly to the manufacturer.

The manufacturer can only be held responsible for the safety, reliability, and performance of the apparatus if:

° assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by him, and

° the unit and approved attached equipment is used in accordance with the manufacturers instructions.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES WHICH EXTEND BEYOND THE WARRANTIES HEREINABOVE SET FORTH. SCHILLER MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCT OR PARTS THEREOF.

Safety Notices

TO PREVENT ELECTRIC SHOCK DO NOT DISASSEMBLE THE UNIT. NO SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL ONLY.

DO NOT USE THIS UNIT IN AREAS WHERE THERE IS ANY DANGER OF EXPLOSION OR THE PRESENCE OF FLAMMABLE GASES SUCH AS ANAESTHETIC AGENTS.

IF THE DISPLAY IS DAMAGED, A LEAKAGE OF FLUID MAY OCCUR. DO NOT INHALE THE VAPOUR FROM THIS FLUID AND AVOID CONTACT WITH MOUTH AND SKIN. IF CONTACT IS MADE, CLEAN CONTAMINATED AREA IMMEDIATELY WITH FRESH WATER.

THIS PRODUCT IS NOT DESIGNED FOR STERILE USE.

SWITCH THE UNIT OFF BEFORE CLEANING AND DISCONNECT FROM THE MAINS.

DO NOT, UNDER ANY CIRCUMSTANCES, IMMERSE THE UNIT OR CABLE ASSEMBLIES IN LIQUID.

DO NOT OPERATE THE UNIT IF THE EARTH CONNECTION IS SUSPECT OR IF THE MAINS LEAD IS DAMAGED OR SUSPECTED OF BEING DAMAGED.

DO NOT USE HIGH TEMPERATURE STERILISATION PROCESSES (SUCH AS AUTOCLAVING). DO NOT USE E-BEAM OR GAMMA RADIATION STERILISATION.

DO NOT USE SOLVENT CLEANERS

USE ONLY ACCESSORIES AND OTHER PARTS RECOMMENDED OR SUPPLIED BY SCHILLER AG. USE OF OTHER THAN RECOMMENDED OR SUPPLIED PARTS MAY RESULT IN INJURY INACCURATE INFORMATION AND/ OR DAMAGE TO THE UNIT.

THE AT-60 COMPLIES WITH EMC REGULATIONS FOR MEDICAL PRODUCTS WHICH AFFORDS PROTECTION AGAINST EMISSIONS AND ELECTRICAL INTERFERENCE. HOWEVER SPECIAL CARE MUST BE EXERCISED WHEN THE AT-60 IS USED WITH HIGH FREQUENCY EQUIPMENT.

IT MUST BE ENSURED THAT NEITHER THE PATIENT NOR THE ELECTRODES (INCLUDING THE NEUTRAL ELECTRODE) COME INTO CONTACT WITH OTHER PERSONS OR CONDUCTING OBJECTS (EVEN IF THESE ARE EARTHED).

THERE IS NO DANGER WHEN USING THE ECG UNIT FOR A PACEMAKER PATIENT OR WITH SIMULTANEOUS USE OF OTHER ELECTRICAL STIMULATION EQUIPMENT. HOWEVER, THE STIMULATION UNITS SHOULD ONLY BE USED AT A SUFFICIENT DISTANCE FROM THE ELECTRODES. IN CASE OF DOUBT, THE PATIENT SHOULD BE DISCONNECTED FROM THE RECORDER.

Safety Notices

THIS UNIT IS CF CLASSIFIED ACCORDING TO IEC 601-1. THIS MEANS THAT THE PATIENT CONNECTION IS FULLY ISOLATED AND DEFIBRILLATION PROTECTED. SCHILLER CAN ONLY GUARANTEE PROTECTION AGAINST DEFIBRILLATION VOLTAGE, HOWEVER, WHEN THE ORIGINAL SCHILLER PATIENT CABLE IS USED.WHEN NON-MEDICAL DEVICES ARE CONNECTED TO THE RS-232 INTERFACE ENSURE THAT BOTH UNITS ARE SECURELY CONNECTED TO THE SAME EARTH POTENTIAL.

WHEN NON-MEDICAL DEVICES ARE CONNECTED TO THE COMMUNICATION INTERFACE, ENSURE THAT BOTH UNITSARE SECURELY CONNECTED TO THE SAME EARTH POTENTIAL.

WHEN OPERATING THE UNIT ON BATTERY AND SIMULTANEOUSLY USING NON.MEDICAL DEVICES, THE RS-232 INTERFACE MUST BE FULLY ISOLATED.

BEFORE USING THE UNIT, ENSURE THAT AN INTRODUCTION REGARDING THE UNIT FUNCTIONS AND THE SAFETY PRECAUTIONS HAS BEEN PROVIDED BY A SCHILLER REPRESENTATIVE.

THE GUIDELINES FOR PATIENT ELECTRODE PLACEMENT ARE PROVIDED AS ON OVERVIEW ONLY. THEY ARE NOT A SUBSTITUTE FOR MEDICAL EXPERTISE.

THE AT-60 ECG UNIT IS PROVIDED FOR THE EXCLUSIVE USE OF QUALIFIED PHYSICIANS OR PERSONNEL UNDER THEIR DIRECT SUPERVISION. THE NUMERICAL AND GRAPHICAL RESULTS AND ANY INTERPRETATION DERIVED FROM A RECORDING MUST BE EXAMINED WITH RESPECT TO THE PATIENTS OVERALL CLINICAL CONDITION. THE RECORDING PREPARATION QUALITY AND THE GENERAL RECORDED DATA QUALITY, WHICH COULD EFFECT THE REPORT DATA ACCURACY, MUST ALSO BE TAKEN INTO ACCOUNT.

IT IS THE PHYSICIANS RESPONSIBILITY TO MAKE THE DIAGNOSIS OR TO OBTAIN EXPERT OPINION ON THE RESULTS, AND TO INSTITUTE CORRECT TREATMENT IF INDICATED.

What's in this Book

THE SERVICE PHILOSOPHY FOR ALL SCHILLER UNITS IS FAULT FINDING TO MODULE LEVEL. THE PURPOSE OF THIS BOOK IS TO PROVIDE ALL THE INFORMATION NECESSARY TO ENABLE THE SERVICE ENGINEER TO EFFICIENTLY LOCATE AND REPLACE A FAULTY MODULE. THIS BOOK ASSUMES NO DETAILED KNOWLEDGE OF THE AT-60 BUT DOES REQUIRE THAT THE SERVICE ENGINEER IS FAMILIAR WITH STANDARD WORKSHOP PRACTICES. ONLY PERSONNEL WHO HAVE ATTENDED A SCHILLER SERVICE TRAINING COURSE ARE AUTHORISED TO CARRY OUT ANY SERVICE PROCEDURES.

The book is divided into the following chapters:

Chapter 1 - Operating Elements

The purpose of this chapter is to provide an easy reference for all the main operator functions and to give a basic introduction to the AT-60. This chapter gives details of the operator controls with the operation and function of each key briefly explained. The information in this chapter provides a background to the operating functions only. Complete operating information is provided in the SCHILLER AT-60 Operating Manual.

Chapter 2 - Functional Overview

This chapter provides a functional overview of the AT-60 The functional description is supported by functional block diagrams.

Chapter 3 - Fault Diagnosis

This chapter provides a guide to locate a fault to module level. The diagnostics are presented in a logical sequence of fault finding algorithms and procedures. Illustrations are provided to support the text where needed.

Chapter 4 - Physical Overview & Module Replacement

This chapter gives an overview of the physical construction of the AT-60 with the main physical attributes of the unit briefly described. The physical description is supported by illustrations showing the internal location of all modules. Removal and Replacement instructions for all replaceable modules are also provided in this chapter. Each procedure is autonomous with details of tools, jumper settings, adjustments, and settings or special requirements that are required before and after replacement. Functional checks that must be carried out after replacing a new module are also provided.

Chapter 5 - Spare Parts

This Chapter provides the part numbers and reordering information for all replaceable modules. Also included in this chapter are details of any special test equipment or special tools required for adjustment or fault finding procedures.

Chapter 6 - Technical Data

The full technical specification of the AT-60 is given in this chapter.

Chapter 7 - Glossary

This Chapter explains all the acronyms and signal titles used in this book and in the AT-60 circuit diagrams.

What's in this Book

Circuit Diagrams & Board Layouts

The circuit diagrams and component layouts are provided for all boards. These details are provided for information only.

We Need Your Help

The philosophy of SCHILLER is one of continuous improvement. Our aim is to provide the user with the most up-to-date information and the latest technological developments. We reserve the right to revise this document and make changes or improvements at any time.

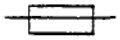
Your suggestions and comments are welcome. Please contact the SCHILLER Technical Documentation Department:

Fax +41 41 761 03 34

List of Symbols

Mains Supply

Battery Operation


Fuse

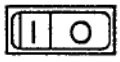
LCD Contrast

Potential Equalisation (common Ground)

Attention - General Warning Sign - see accompanying documentation

Type BF equipment - safe for external applications

Manufacturers Take-back guarantee for used batteries


O - Mains Power Off - mains supply disconnected from unit
I - Mains Power On - mains supply connected to unit

ON/OFF

Chapter 1
Operating Elements

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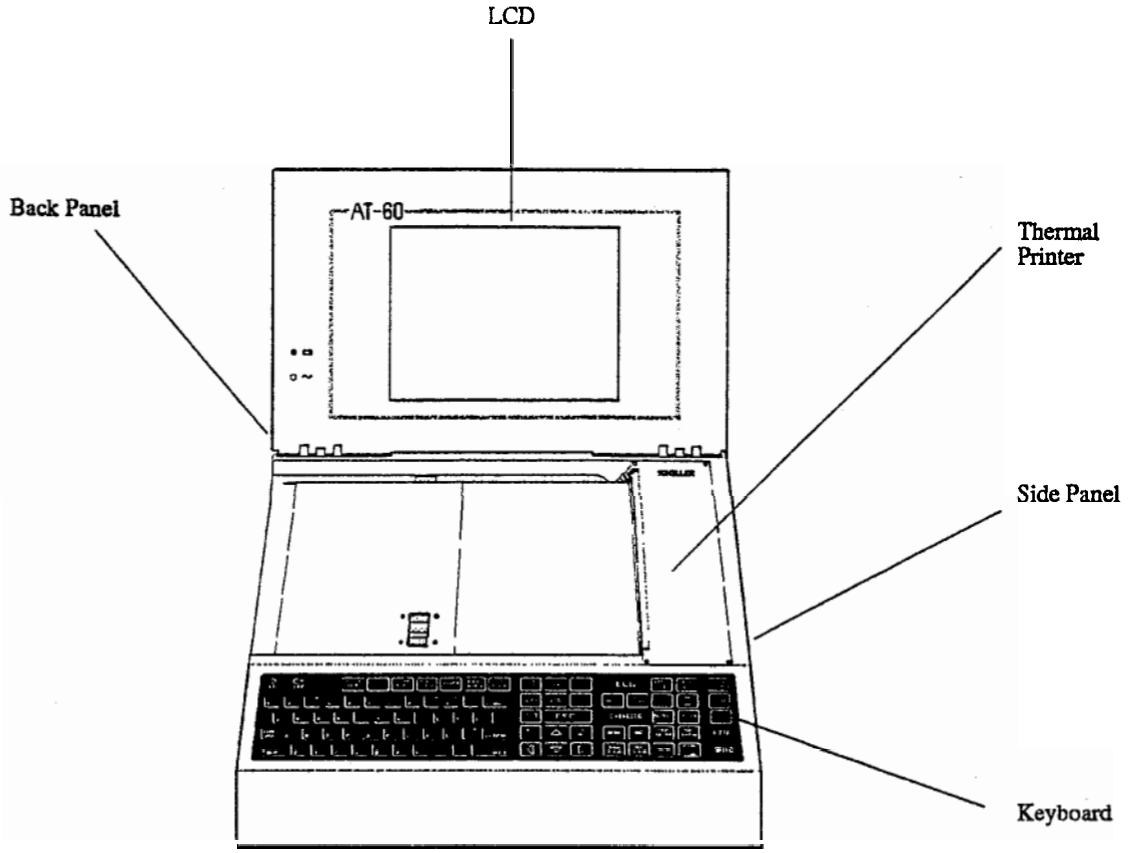
Introduction



The Schiller Cardiovit AT-60

The CARDIOVIT AT-60 is a compact work-station for cardiological diagnosis. It has the facility to carry out both resting and exercise ECGs with the test results displayed on the integral LCD and optionally recorded on the built-in thermal printer.

Three RS-232 interfaces and one RS-422 interface are provided for the connection of digitally controlled exercise test equipment, blood pressure equipment, and for data transmission/reception. The unit also has facilities for connection of an external video monitor, an external keyboard, experimental DC inputs, and analog controlled exercise equipment.

With ECG program options, the AT-60 can be upgraded to provide ECG interpretation, exercise test evaluation, pacemaker measurement and Frank vector loops. The Spirometry option enables Spirometry tests to be performed and pulmonary function diagnosis to be carried out.

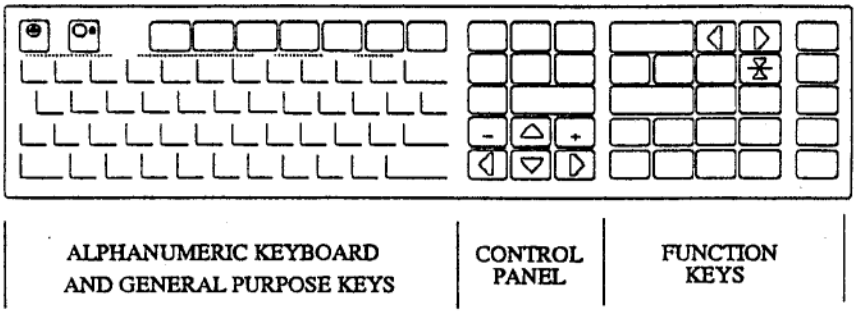
The AT-60 can be connected to the Schiller PC based data management program (designated SEMA), for the validation and archiving of recorded data.

Introduction (cont.)

The main operating and connection modules of the Cardiovit AT-60 are as follows:

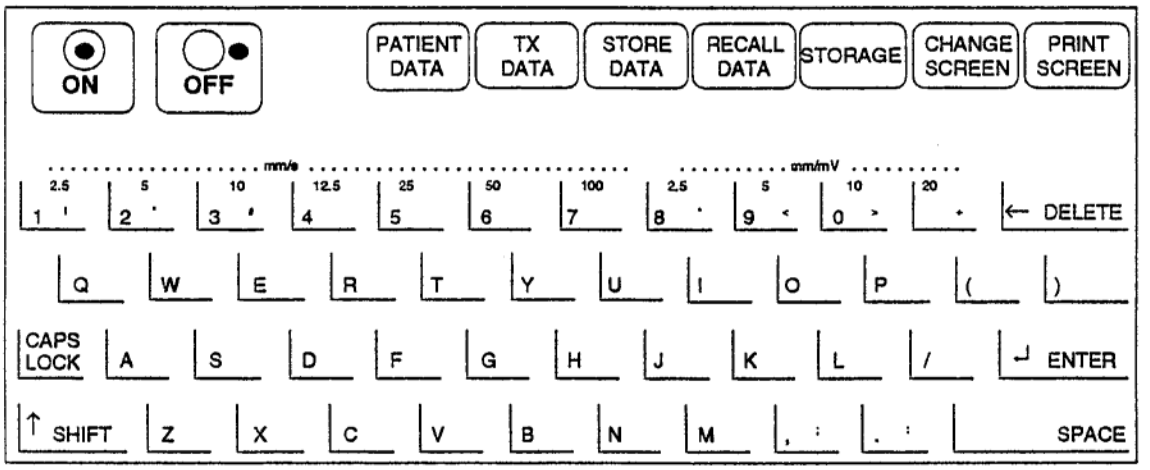
- **Keyboard** — The keyboard is divided into three functional areas. The left-hand side comprises an alphanumeric keypad, the AT-60 ON / OFF keys, and seven general function keys. The central area contains control keys, and the right-hand area contains the main function controls.
- **LCD Screen** — The LCD screen displays the real-time ECG traces and certain operating and status information. Under operator control the display also gives menu options and displays operator entered data. The display is folded down when not in use.
- **Thermal Printer** — The printer provides hard copy of test results.
- **Side Panel** — The side panel contains dc input connectors, a data input/output connector, an external video monitor, and an external keyboard connector. The side panel also contains the ECG connector and an aperture for insertion of the program pack.
- **Rear Panel** — The rear panel contains the RS serial connectors and the mains connector with on/off switch, voltage selector and mains fuse.

Keyboard



Alphanumeric Keyboard and General Purpose Keys

The alphanumeric keyboard provides the user with the means for data input as well as direct access to specific functions. The keyboard is arranged as follows:

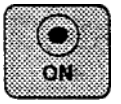


At the top left are the keys for switching the unit on and off. To the right of these two keys are the dedicated keys for miscellaneous general purpose functions.

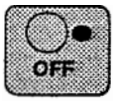
Below the general purpose keys is the alphanumeric keyboard. The top line of the keyboard is dual purpose and when the unit is in the ECG mode, these keys double as control for the direct setting of speed and sensitivity for manual printout. Otherwise, the alphanumeric keyboard serves as a normal keyboard for data input.

Keyboard (cont.)

The general purpose keys are as follows:



Switches the unit on



Switches the unit off

Entry of patient data

Initiate data transmission

Initiate data storage

Initiate receive mode

Main menu for data archive and data recall from storage

Switch displayed information

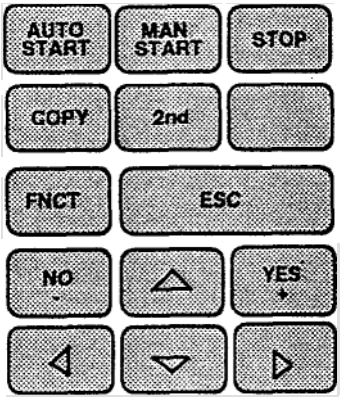
Print screen contents

The functions of the dual purpose keys on the alphanumeric keyboard are as follows:

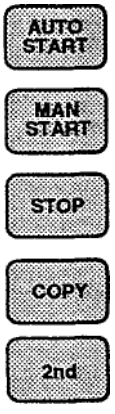
DUAL PURPOSE KEYS	
KEY	**FUNCTION**
`1´ to `7´	Printout Speed Selection 2.5, 5, 10, 12.5, 25, 50, or 100 mm/s
`8´ to `_´	Printout Sensitivity Selection 2.5, 5, 10, or 20 mm/mV

Control Panel

The Control Panel contains the function keys which are common to all function modules. It is arranged as follows:



The keys are as follows:



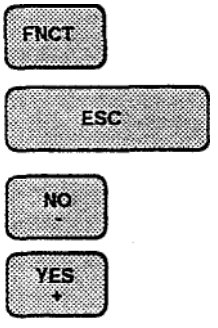
Start automatic recording

Start manual recording

Stop printout / move paper to start position

Initiate copy

Select second function



Call up main menu / return to Monitor mode

Return to previous menu

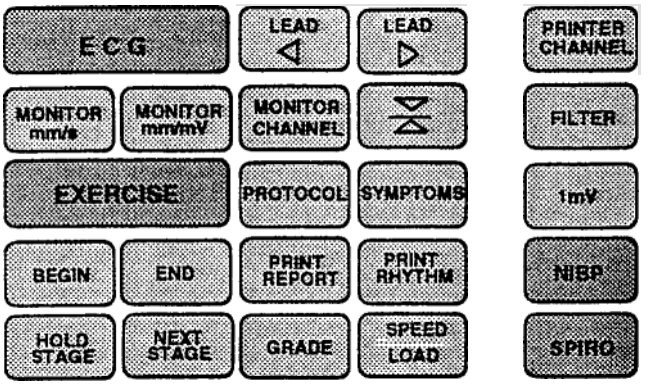
Change setting / disable command

Change setting / enable command

Note: Slight functional differences may exist in different modes

Function Keys

The function keys are arranged in a group to the right of the Control Panel. The top part of the group comprises keys for the resting ECG recording functions and the bottom part comprises keys for the exercise ECG functions. At the bottom right of the group is the **SPIRO** key for the optional pulmonary function testing program. The following is a summary of the keys and their functions:



Resting ECG Function keys

ECG	Select resting ECG menu.
LEAD ▷	Lead selection, forwards
LEAD ◁	Lead selection, backwards
MONITOR mm/s	Selection of display speed, 25 or 50mm/s
MONITOR mm/mV	Selection of display sensitivity, normal or half amplitude
MONITOR CHANNEL	Channel selection for display, 3, 6 or 8
▷◁	Signal Centering
PRINTER CHANNEL	Channel selection for printout, 3, 6, 12 or user programmed
FILTER	Myogram filter on / off (150Hz = off)
1mV	Manual 1 mV pulse
SPIRO	Menu for spiro measurement (Option)

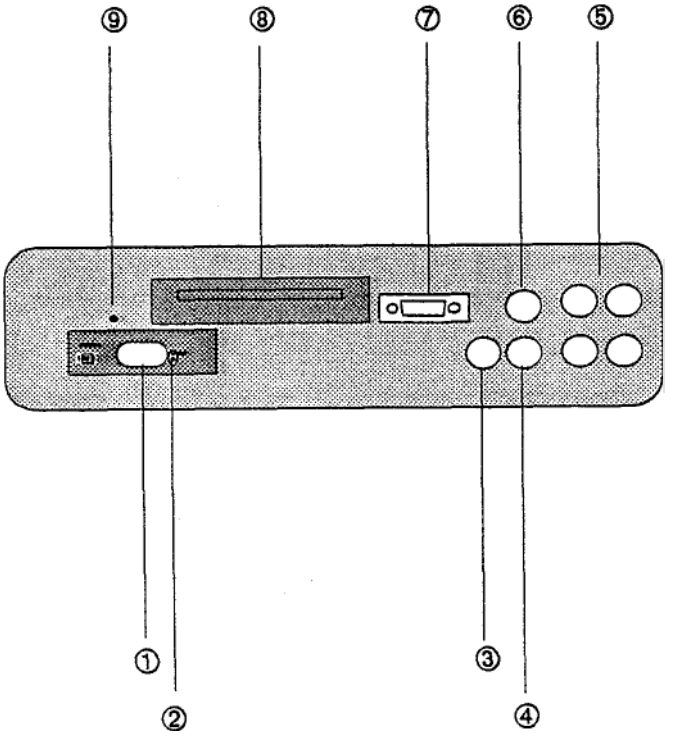
Exercise ECG Function keys

EXERCISE	Select exercise test menu.
PROTOCOL	Display / select protocol
SYMPTOMS	Manual input of symptoms
BEGIN	Start exercise test
END	Stop Load
PRINT REPORT	Print out final report
PRINT RHYTHM	Print out rhythm lead
HOLD STAGE	Hold current load stage
NEXT STAGE	Initiate next load stage
GRADE	Increase treadmill elevation
SPEED LOAD	Increase speed (treadmill) or load (bicycle)
NIBP	Menu for non-invasive blood pressure measurement

Connector panels

The AT-60 has two input/output panels and a Mains Panel. The two input/output panels are located on the right-hand side of the unit and the Rear Panel respectively. The Mains Panel is located at the rear of the unit.

Side Panel



The following are located on the side panel:

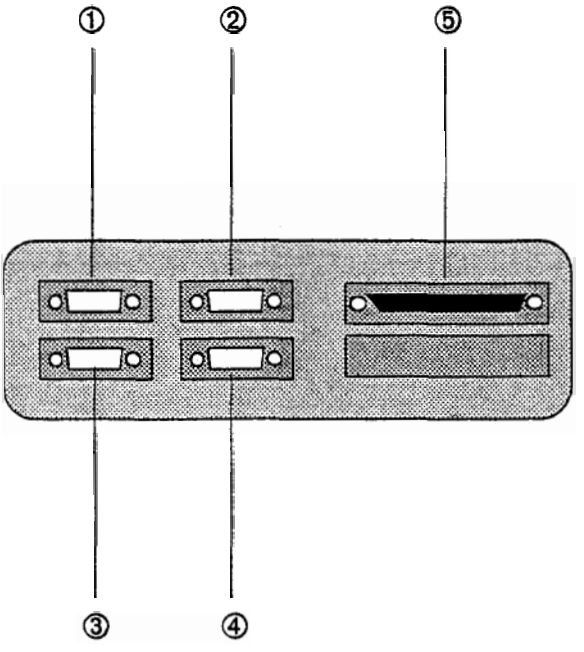
1. EKG / ECG Socket for patient cable

   Note: The socket is CF rated ie fully floating and isolated, defibrillation protected, suitable for intra-cardiac application.

2. Test socket for electrode leads with control light
3. Connector for an external keyboard
4. Data I/O socket for connection of foot-switch, QRS trigger, treadmill elevation control
5. Experimental DC inputs: DC1/2, DC 3/4, DC 5/6, DC 1 - 6
6. Exercise (stress) test connection for analogue ergometers (bicycle or treadmill)
7. Connector for external video
8. Program Pack
9. Master reset button, restart the AT-60 by inserting the tip of a pencil into this recess to press the reset button.

Connector panels (cont.)

Back Panel

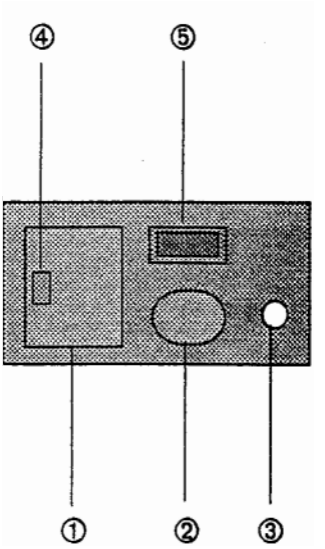


The following connectors are located on the back panel:

1. 1 X RS-232C interface for connection of a blood pressure measuring device (Port 1)
2. 1 X RS-232C interface for connection of an ergometer (bicycle or treadmill) (Port 2)
3. 1 X RS-232C interface for data transfer (Port 3)
4. 1 X RS-422 interface for data transfer
5. Connection for SP-100 or SP-100/R flow sensor for lung function measurements (Option)

Connector panels (cont.)

Mains Panel



The following are located on the mains panel:

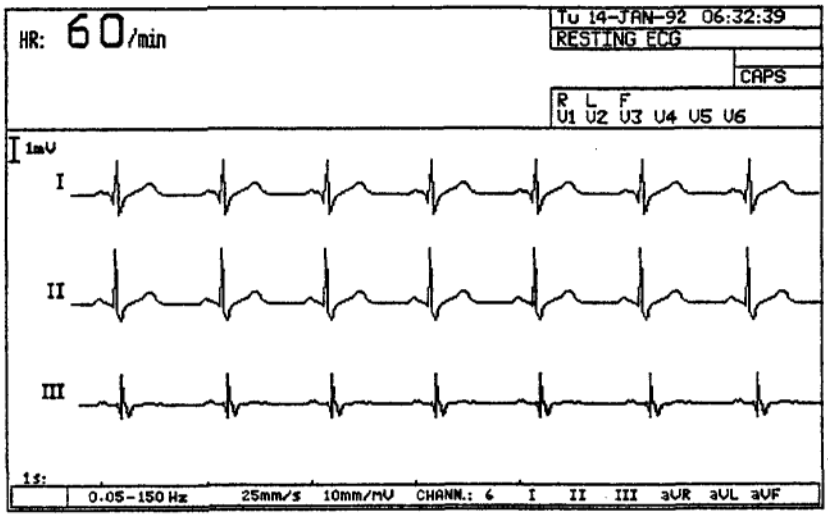
1. Mains fuse and voltage selector
2. Mains connection
3. Potential equalisation (ground) connection
4. Voltage indicator (mains)
5. Power on / off switch

Liquid Crystal Display

The liquid crystal display (LCD) performs both as a real-time monitor and as an alphanumeric display for menu selection, data input and the provision of important information.

The angle of the display can be adjusted to one of three different positions to provide the best visibility or can be folded down when not in use. The contrast can be adjusted by means of the LCD control located on the right-hand side of the screen.

A typical display of an ECG recording (with patient simulator connected) is as follows:



Depending on the function, the displayed information will vary but the screen is normally divided into three general areas as follows:

- The top of the screen gives status and operating information. These are permanently displayed.
- The central part of the screen is taken up with the measured waveform (ie ECG trace, Lung function curve, etc) with the lead identifications or measurement units on the left-hand side.
- The bottom of the screen displays the time interval of the recording, indicated in seconds. The very bottom line gives, from left to right:
  - ◊ Selected Baseline and Myogram filter settings
  - ◊ Speed, sensitivity and the number of channels (for direct (manual) print-out)
  - ◊ The leads that are selected for the printout (for direct (manual) print-out)

Calibration

At any time during the ECG recording, a 1mV calibration signal can be manually produced by pressing the <1mV> key on the right-hand side of the keyboard. This 1mV square wave signal is indicated both on the display and on the printout.

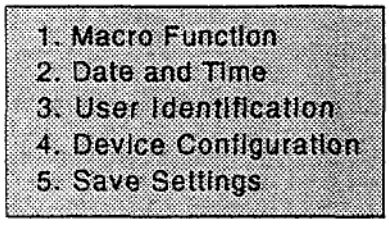
Manual Baseline Reset

Pressing the manual baseline recentre key ⧖ resets the displayed traces to the optimal position.

Use this key to centre the real-time ECG traces, when `drifting´ occurs.

System Setup

There are several general settings for the AT-60. Press the <FNCT> key to call up the initial menu. Two options are presented. Option 1 is for entry of the operator information - MTA (Medical technical Assistant). The second menu item is the setup option. Press key <2> and the System Setup menu is displayed as follows:



When the menu is entered, the cursor is always located on the first item. There are two ways to select a particular menu item as follows:

◊ press the number indicated to the left, or

◊ use the direction keys to move the cursor to the item required and press the <ENTER> key.

Most of the options in the setup menu are self explanatory however, the macro function and the save setup options are detailed here for completeness.

Defining Macro Functions

With the AT-60 you can create your own macro functions and assign them to one of the first six numerical keys on the alphanumeric keyboard. Up to 30 keystrokes can be stored for one macro enabling you to call up a particular sub-menu or to carry out a particular programming sequence by pressing only two keys. Please note, however, that it is not advisable to program functions with a multiple choice selection (eg "Format for Automatic Mode" in the ECG menu) in this manner as the starting point may not always be the same.

Note: Before starting to program a macro, it is advisable to carry out the sequence making a note of the order of the key strokes for reference.

In the System Setup menu, press key <1> to call up the Macro function input menu. To start the programming sequence, press key <I> , then the number key which you wish to program and then carry out the required sequence.

Once the sequence is completed, press the <2nd> key followed by the <ESC> key and storage of the keystroke sequence is confirmed by an audible tone.

To initiate a programmed Macro sequence, press the <2nd> key and then the programmed number key on the alphanumeric keyboard. The sequence will remain stored until a new sequence overwrites the existing macro programmed for that key.

Example: Pre-set programmable leads

Proceed as follows:

1. Press the <FNCT> key, <2>, <1> Macro function
2. To start programming the sequence press <I> (Input) and then <1> (macro function starts with F1).
3. Press <ECG>, <6> (ECG Settings), <6> (programmable leads) - cursor is located on lead 1.

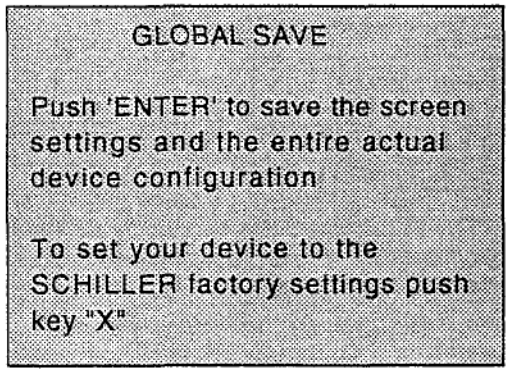
System Setup (cont.)

4. Press </> (slash) to set the zero reference - lead 1 changes to I.
5. Press key <1> until the desired lead 1 is displayed.
6. Use the down cursor to move to the next programmable lead, set zero reference with </> and press key <2> until the desired lead 2 is displayed.
7. Proceed in the same way for all remaining leads. *Please note that maximum 30 keystrokes can be stored in a macro.*
8. Press the <FNCT> key to get away from the menu.
9. Press the <2nd> key and then ESC. Storage of the keystroke sequence is confirmed by an audio sequence.

To initiate this macro, press the <2nd> key and then key <1> (F1).

Save Settings

Programmable parameters can be stored as base settings. These stored settings are not erased when the unit is switched off. To call up this function, select the last item in the System Setup menu and the Save Settings menu is displayed as follows:


GLOBAL SAVE
Push 'ENTER' to save the screen settings and the entire actual device configuration
To set your device to the SCHILLER factory settings push key "X"

The device configuration and the screen settings will be saved as base settings so that they are available each time the unit is switched on.

See the AT-60 Operating Manual for full explanation of the settings.

By pressing <ENTER>, the settings will be permanently stored and confirmation is given with the message

**** Settings memorized! ***.*

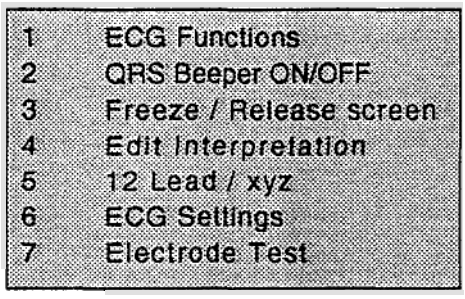
By pushing key "X" the factory settings are restored, which is confirmed with an audio signal and the display:

***

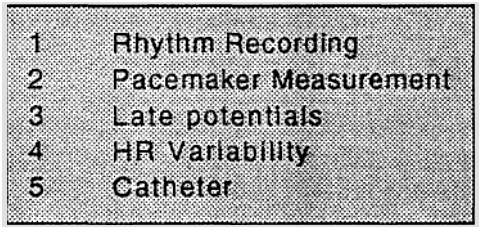
Press ENTER to memorize the settings and <FNCT> to get out of the menu.

ECG Menu

To call up the menu for any of the main functions, simply press the respective function key (eg <ECG> for resting ECG, <EXERCISE> for exercise ECG, etc). To return from any menu directly to the Monitor mode, press the <FNCT> key. To return from any menu to the previous menu, press the ESC key. To call up the main resting ECG menu, press the ECG key.



By pressing key <1> the ECG functions menu is displayed.



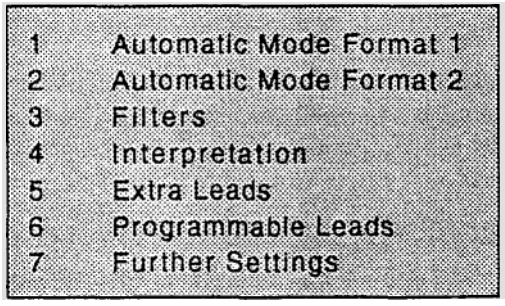
Rhythm Recording

Under this menu item the leads desired for rhythm recording can be selected.

The other menu items are self-explanatory.

ECG Settings

By pressing key <6> in the ECG menu, the available settings for resting ECG recording are displayed.



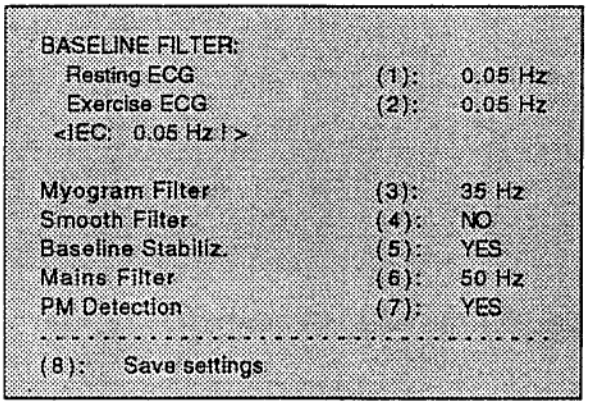
Automatic Mode

Under these menu items all the relevant settings for the printout in Auto mode 1 and 2 can be set.

ECG Menu (cont.)

Filters

There are three filters which can be set before starting the recording of an ECG. To call up the menu for these filters, press the <ECG> key, then select menu option `ECG Settings´ followed by `Filters´. The following menu is displayed:


BASELINE FILTER:
Resting ECG (1): 0.05 Hz
Exercise ECG (2): 0.05 Hz
<IEC: 0.05 Hz !>
Myogram Filter (3): 35 Hz
Smooth Filter (4): NO
Baseline Stabiliz. (5): YES
Mains Filter (6): 50 Hz
PM Detection (7): YES
(8): Save settings

Baseline Filter

A digital baseline filter has been designed in order to suppress excessive baseline drifts. By pressing key <1> (for resting ECGs) or key <2> (for exercise ECGs), the setting can be altered to one of the following values: 0.50, 0.25, 0.12 or 0.05 Hz. The value set is the lower limit of the frequency range and is normally set to 0.05Hz (IEC recommendation), ie a frequency range of 0.05 to 150Hz.

The settings 0.12, 0.25 and 0.50Hz should only be used when absolutely necessary as the possibility exists that they could affect the original ECG signal, especially the ST segments.

Pressing key <5> toggles the pacemaker detection circuit on or off.

The current baseline filter setting is indicated at the bottom of the screen. Once the setting has been changed, firstly press the <FILTER> key in order to reset this indication.

Myogram Filter

The myogram filter suppresses disturbances caused by strong muscle tremor. This filter can be switched on and off by pressing the <FILTER> key. When set to off, the displayed setting will be 150Hz. When set to on, the selected cut-off frequency (25 or 35Hz) will be indicated.

To alter the setting for the filter, press key <3 >and the cut-off frequency can be set to either 25 or 35Hz. The current Myogram filter setting is indicated at the bottom of the screen to the right of the baseline filter setting. Once the setting has been changed, press the <FILTER> key in order to reset this indication.

The stored ECG can be printed either with or without passing the myogram filter.

Note: Using the myogram filter causes wave amplitudes on the printout to be reduced by as much as 20%. Average cycles and measurement values however are not affected by this filter.

ECG Menu (cont.)

Mains Filter

The mains filter is an adaptive 50Hz / 60Hz digital interference filter designed to suppress ac interference without attenuating or distorting the ECG. By pressing key <4>, the filter can be set according to country requirements to either 50Hz (for most European countries) or 60Hz (for the USA) or switched off.

Number of printed copies

The number of copies to be printed out can be pre-selected. To do this, press the <ECG> key, select the `ECG Settings´ menu option and then 'Further Settings' followed by `Number of copies´. The currently selected number of copies is then displayed as follows:

Number of copies (1): 2

Press key <1> consecutively to select the required number of copies (either 1, 2, 3, 4 or none). Press <9> to confirm and save settings.

The unit will now produce the specified number of ECG copies whenever the <AUTO START> or <COPY> key is pressed.

Lead Sequence

The lead sequence can be set to either Standard or Cabrera. The sequence required can be selected by pressing the <ECG >key, selecting the `ECG Settings´ menu option followed by `Further Settings´ and `12 Lead Sequence´. The currently selected sequence is then displayed as follows:

12 Lead Sequence (2): Standard

Press key <2> to toggle between Standard and Cabrera.

User-programmable Lead Group

The user-programmable group comprises 12 leads which can be individually programmed. To program these leads, press the <ECG >key, select the `ECG Settings´ menu option followed by `Programmable Leads´. The following table is then displayed:

PROGRAMMABLE LEADS

Lead 1	(1):	II	Lead 7	(7):	aVR
Lead 2	(2):	aVF	Lead 8	(8):	aVL
Lead 3	(3):	III	Lead 9	(9):	aVF
Lead 4	(4):	V2	Lead 10	(0):	V2
Lead 5	(5):	V5	Lead 11	(A):	V4
Lead 6	(6):	V6	Lead 12	(B):	V6

(C): Save settings

To program your own lead group, simply enter the number of the lead and press it consecutively until the desired lead is displayed. Proceed in this way for all 12 leads and press <C> to confirm and save settings.

Extra Leads

The following extra leads can be programmed:

- V7, V8, V9 — the three additional leads for determining left bundle branch block or lateral infarct.
- X, Y, Z (13) — for the standard 12 leads plus the three Frank leads whereby I = C7, H = C9 and M = C8.
- D, A,J — for the Nehb leads whereby Nst = C7, Nap = C9 and Nax = C8.

  Note: The above three additional lead groups can only be recorded when the Schiller 13-lead patient cable is used.
- X, Y, Z (BIP) — for the Frank bipolar leads whereby X = C4-C1, Y = C3-C6 and Z = C5 C2.
- X, Y, Z (10) — for the Frank XYZ leads using the normal 10-lead patient cable where C1 = I, C2 = E, C3 = C, C4 = A, C5 = M, C6 = H, L = LA and F = LF.

To program additional leads press the <ECG> key, select `ECG Settings´ followed by `Extra Leads´. Press key <1> consecutively until the desired group is displayed.

Programmable channels for printout

The number of channels for the printout can be set to either 3, 6, 12 or a user-defined number. To set this user-defined number, press the <ECG> key, then select the `ECG Settings´ menu option followed by `Further Settings´ and `Programmable Channels´. The currently selected number of channels is then displayed as follows:

Programmable Channels (3): 4

Press key <3> consecutively until the required number of channels (ie, 4, 5, 7, 8, 9, 10 or 11) is displayed. Confirm and save the setting by pressing key <9>. This setting is particularly useful when, for example, additional Doppler or phono waveforms are to be recorded through the experimental inputs.

Note: Selection of the number of channels (ie, 3, 6, user defined or 12 channels) is performed by pressing the <PRINTER CHANNEL> key and the current selection is indicated at the bottom of the screen.

Chapter 2
Functional Description

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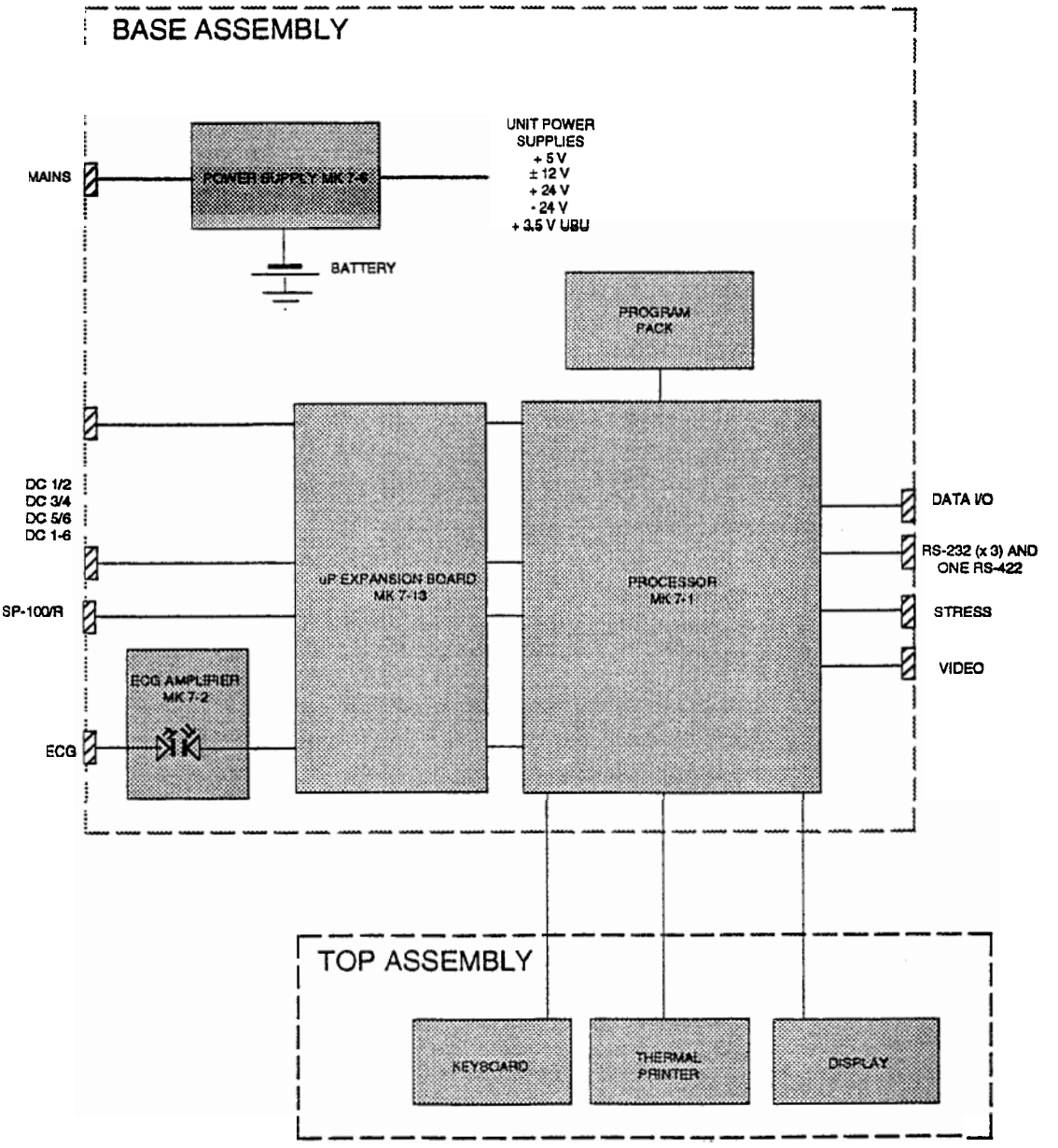


Fig 2.1 AT-60 Basic Block Diagram

Brief Description

The AT-60 comprises the following boards and major functional areas:

Power Supply

The power supply rectifies the mains input to generate all the required voltages for the AT-60 electronics. A rechargeable battery supplies power for the real time clock and enables the AT-60 to function for about 45 minutes, when mains is not present.

Processor Board

The Processor Board is the master control for all peripherals and contains the main CPU and timing circuits, and the unit RAM memory. This board also contains the video signal generation circuits (which are converted in the Top Assembly to LCD signals) and the slot-in Program Pack which contains the software for the unit. The Processor Board communicates externally over the following connectors.

- Serial RS-232 and RS-422 interfaces for connection of RS controlled treadmills and blood pressure measuring equipment. A port is also available for data transmission to other ECG equipment or to an external computer for data evaluation and storage.
- The Stress Connector provides an analog output to control the speed of a treadmill or the load on a bicycle ergometer. An analog signal is returned from the treadmill to indicate the current elevation and speed.
- The Data I/O connector is used for the following:
  - a foot-switch input
  - QRS trigger output
  - control signal for treadmill elevation
- The Video connector enables an external monochrome VGA standard monitor to be connected. The digital video signal reflects the current LCD display.
- The Keyboard connector accepts a serial digital input from an external PC style keyboard.

ECG Amplifier Board

This board amplifies and carries out some signal processing on the incoming ECG signals. To ensure absolute safety of the patient, all incoming/outgoing data is via opto-isolators.

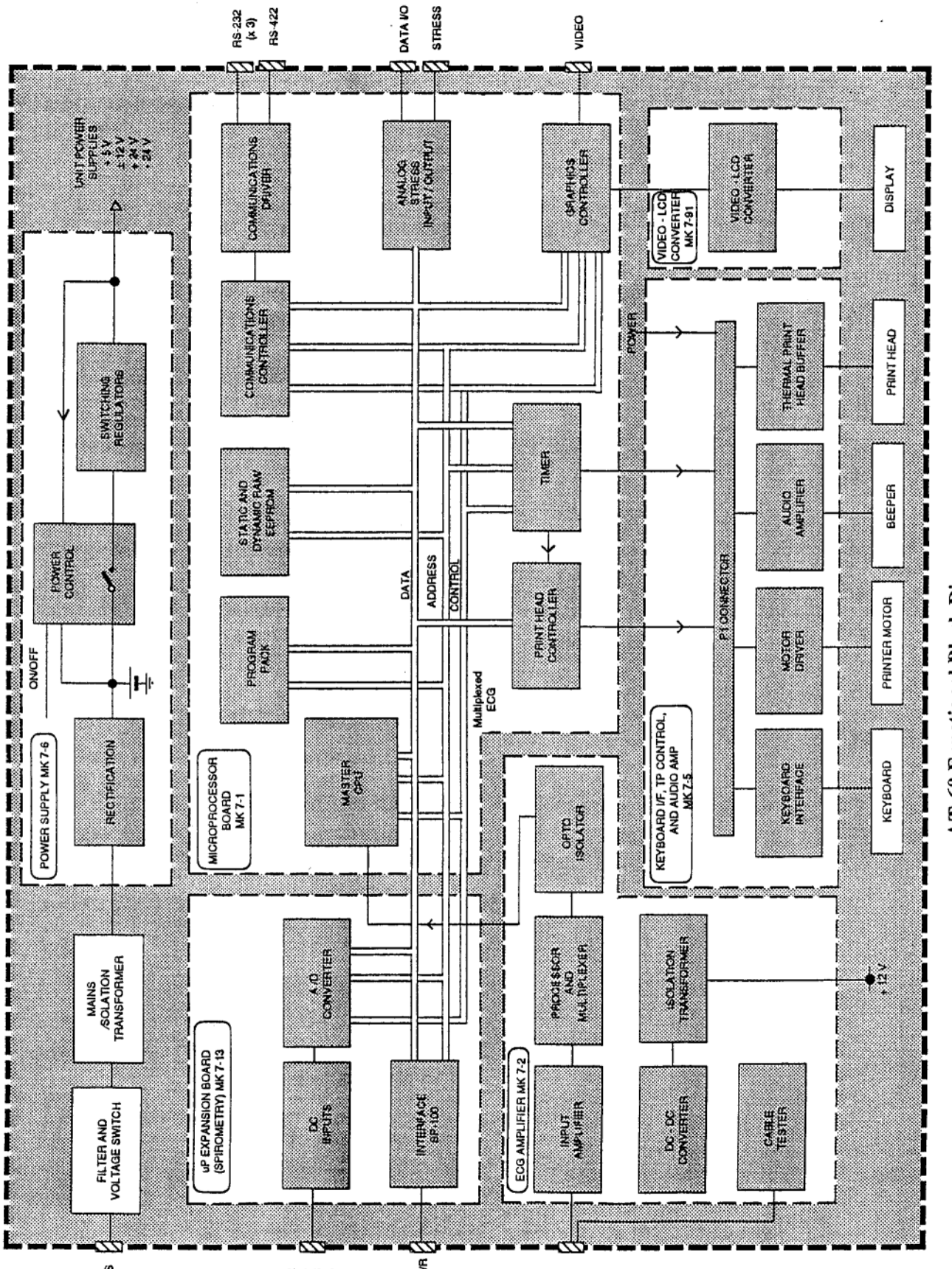
Bus Interface

The Bus Interface board carries out two main functions as follows:

- interfaces the digital input from the Spirometry connector
- converts incoming analog signals from the DC input connectors, to a digital signal.

Top Assembly

The Top Assembly contains a keyboard interface circuit, a beeper (audio) amplifier, a controller/driver circuit for the printer motor and print head buffers. Also located in the Top Assembly is the Video / LCD converter board; this board converts the video signal, generated on the Processor board to LCD signals. (Print control, keyboard timing, and graphics control and signal generation circuits are on the Processor Board.)



AT-60 Functional Block Diagram

Overall Functional Description

Power Supply

Mains is applied to the power supply via a mains filter, on/off switch and a voltage selection switch. The voltage selection switch connects the supply to the relevant winding of the mains isolation transformer. The ac voltage is then rectified to produce a resultant dc voltage of approximately 25V. This voltage is applied to four switching regulators which generate all of the dc power supplies required by the unit. When mains is not connected the supply voltage for the switching regulators is supplied from the battery. The battery is charged when mains is connected.

All of the generated supplies are constantly monitored by the power control circuit; if an overvoltage is detected, the power supply to the switching regulators is cut and the unit is immediately switched off. The power control circuit also monitors the battery voltage and the on/off keys on the keyboard and switches the unit off when the Off key is pressed or when the battery voltage falls below 9.2V.

Processor and Memory

The AT-60 is controlled by a high speed, CMOS 68000 processor with a 16-bit data bus and 23-bit address bus. The clock speed is 16.7 MHz. The working RAM memory comprises 256 kByte of static RAM and 4MByte of dynamic RAM. An EEPROM holds the operator selectable parameters. The dynamic RAM holds the measured data and other variables. The unit software comprises 256kBytes of EPROM memory contained on the program pack. A digital signal processing chip, also situated on the program pack, is used for real-time processing of ECG data.

Spirometry

The serial input signal from the spirometer is connected to the interface circuit. The serial data is clocked into a shift register in the interface circuit and, when enabled the data is presented in parallel on the data bus for interpretation by the master CPU.

ECG

The ECG signal from the patient is low pass filtered, amplified and applied to the processor and multiplexer circuit which carries out the following:

- Analog to digital conversion of the ECG signal at a sampling rate of 4kHz
- Reduction of the sampling rate to 1kHz
- Determination of the pulsewidth of a pacemaker signal
- Transmission of the processed ECG (and PM measurements and status signals) over the opto-isolators

The serial input/output is transmitted to the master CPU at 2.5 MBaud and commands are received from the master CPU at 38.4 kBaud. To ensure absolute patient safety, an isolation transformer galvanically isolates the AT-60 power supply from the patient. A cable tester circuit is also incorporated on this board which is automatically activated when a patient lead is connected to the test point. This allows open circuit testing of the electrode leads.

Overall Functional Description (cont.)

Keyboard

The keyboard is a matrix style circuit which is periodically scanned by the processor via the Keyboard Interface circuit. When a key is pressed, the key information is clocked to the processor board for interpretation by the master CPU.

Printer Control

The Thermal Print Head is controlled by the Print Head Controller circuit and the Timer circuit. The print head controller serialises the parallel data written by the CPU into a 16-bit FIFO register. The Timer circuit controls how long current is applied to the head, and thus the intensity of the print-out.

The printer motor speed is controlled by the master CPU via the Timer circuit.

Graphics Control

The display data is generated in the graphics processor circuit under the control of the master CPU. The graphics processor outputs a VGA standard serial video signal. This signal is then converted to an LCD signal by the Video - LCD circuit which presents the data to the display.

Miscellaneous Inputs/Outputs

DC Inputs

The dc input connectors allow analog signals, for example from an ultra sound device or a phono / pulse recording unit, to be input to the AT-60. The analog inputs are converted to a digital level and, when enabled presented on the data bus. The maximum input voltage is 2.5 V p-p.

Video Connector

The video connector outputs the serial video signal generated by the graphics processor. The video connector reflects the same data as that displayed on the LCD.

Stress Connector

The analog stress I/O circuit contains a digital to analog converter that converts load or speed control data to an analog voltage. The elevation and speed of the treadmill is returned, as an analog value and converted to digital data for interpretation by the main CPU. When a bicycle is connected an analog signal representing the load is sent and received.

Serial Ports

The Communications Controller contains USARTS which generate serial signals for the transmission and reception of data. The Communications Driver circuit contains interface circuits to ensure signal level compatibility with RS-232. The RS-422 connector is used when high data rates are required or when longer cable lengths are used.

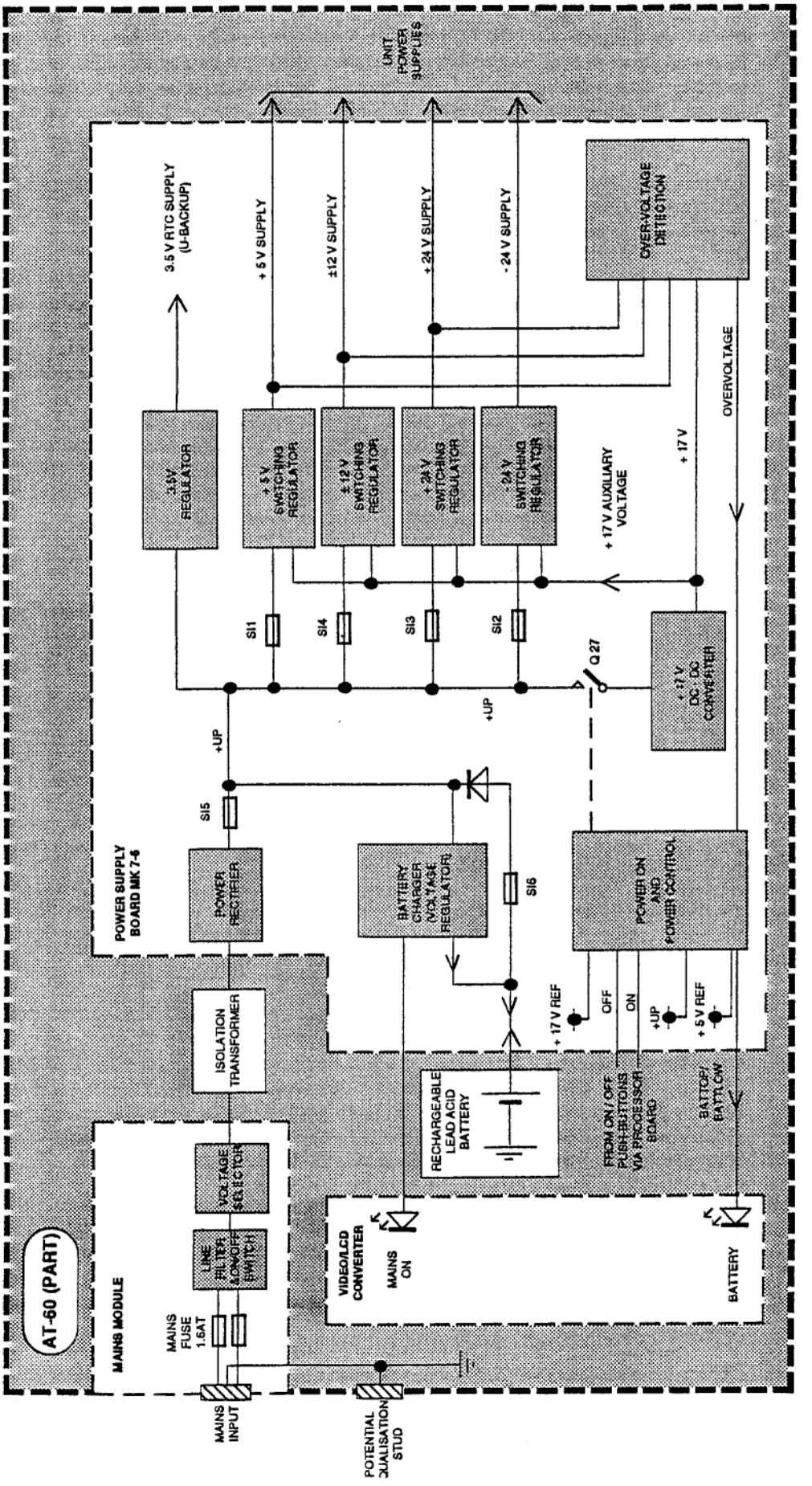
Data I/O Connector

This connector is used for the input/output of the following:

- Foot-switch input
- Elevation control signals to an analog treadmill
- QRS trigger signal output

External Keyboard Connector

The keyboard connector accepts serial data from an external PC- type keyboard. The incoming data is converted to parallel by the communication controller circuit.



Power Supply - Functional Block Diagram

Power Supply

Mains is applied to the line filter via the on/off switch and two 1.6 A, slow-blow fuses. The line filter incorporates a temperature variable resistor to ensure that the current is limited at initial switch-on. After a few seconds the resistor warms, the resistance drops and normal power is supplied. The voltage switch ensures that the correct primary winding of the isolation transformer is used for the mains voltage applied.

The transformed ac input is full-wave rectified by a bridge rectifier with a Π - filter circuit to produce a dc voltage (+UP) of between +25V and +26V. This voltage is used by all the power regulator circuits in the power supply.

Four switching regulators provide the general unit power supplies and in addition a voltage regulator circuit provides the 13.8 V battery charge voltage and the 3.5 V back-up supply for the real time clock. A +17V supply is also generated on the Power Supply board which is used exclusively on the power supply control circuits as an auxiliary voltage for the switching circuits and as an enable voltage for control of the +5 V, +12 V, +24 V and -12 V voltage regulators.

The switching regulators all work in a similar way with a PWM (pulse width regulator chip (U1 for the +5V regulator) controlling a power MOS FET (Q4). The FET acts as a switch to control the supply to the primary winding of transformer T1 and thus regulate the supply. The output is filtered by C4, C5, C18. The frequency regulator chip is controlled by feedback from the power rail to control the pulse width output to Q1. Each power supply is separately fused.

The power supply distribution is given on the following table.

POWER SUPPLY DISTRIBUTION						
BOARDS	POWER SUPPLIES					
	+ 5 V	+ 12 V	- 12 V	+ 24 V	- 24 V	+ 3.5 V
Processor Board	✓	✓	✓			✓
Keyboard I/F, TP Controller and Audio Amplifier	✓	✓		✓		
Video/LCD Converter	✓				✓	
ECG Amplifier	✓	✓				
Bus Interface	✓	✓	✓			

Power On and Power Monitoring and Control

The power on and power control circuit sets a relay which switches the supply voltage to the + 17V PSU. The +17V is the auxiliary voltage for the power supply. When the + 17 V PSU is disabled, all PSUs (except the + 3.5 V and the 13.8V battery charge regulator) are disabled, and the unit is switched off. The output from the +17V PSU is + 17 V when the unit is working from the mains, or the battery supply voltage when the unit is working from the battery.

The + 17 V PSU comprises a dc-dc converter chip (U15) and a switching regulator circuit (FET Q 25 and Schmitt trigger U1 and associated components). The switching regulator circuit is active when the voltage drops below + 17 V to maintain a constant voltage. The frequency of the switching regulator is approximately 96 kHz with a saw-tooth waveform generated by C107. The output from the voltage follower U14A is 0 V when working from the mains, and 10 V when working from the battery.

Power Supply (cont.)

The +UP supply voltage to the dc-dc converter is switched by electronic switch Q27 and the power on and control circuit. The power control circuit is a latch circuit comprising FET Q24 and associated components. When the ON signal is active (low) FET Q24 is saturated and latched on by Q26. When an OVERVOLTAGE signal, OFF signal or the BATTDOWN signal goes active low, Q26, Q24 and Q 27 are switched off and thus the unit is latched off.

Battery Operation

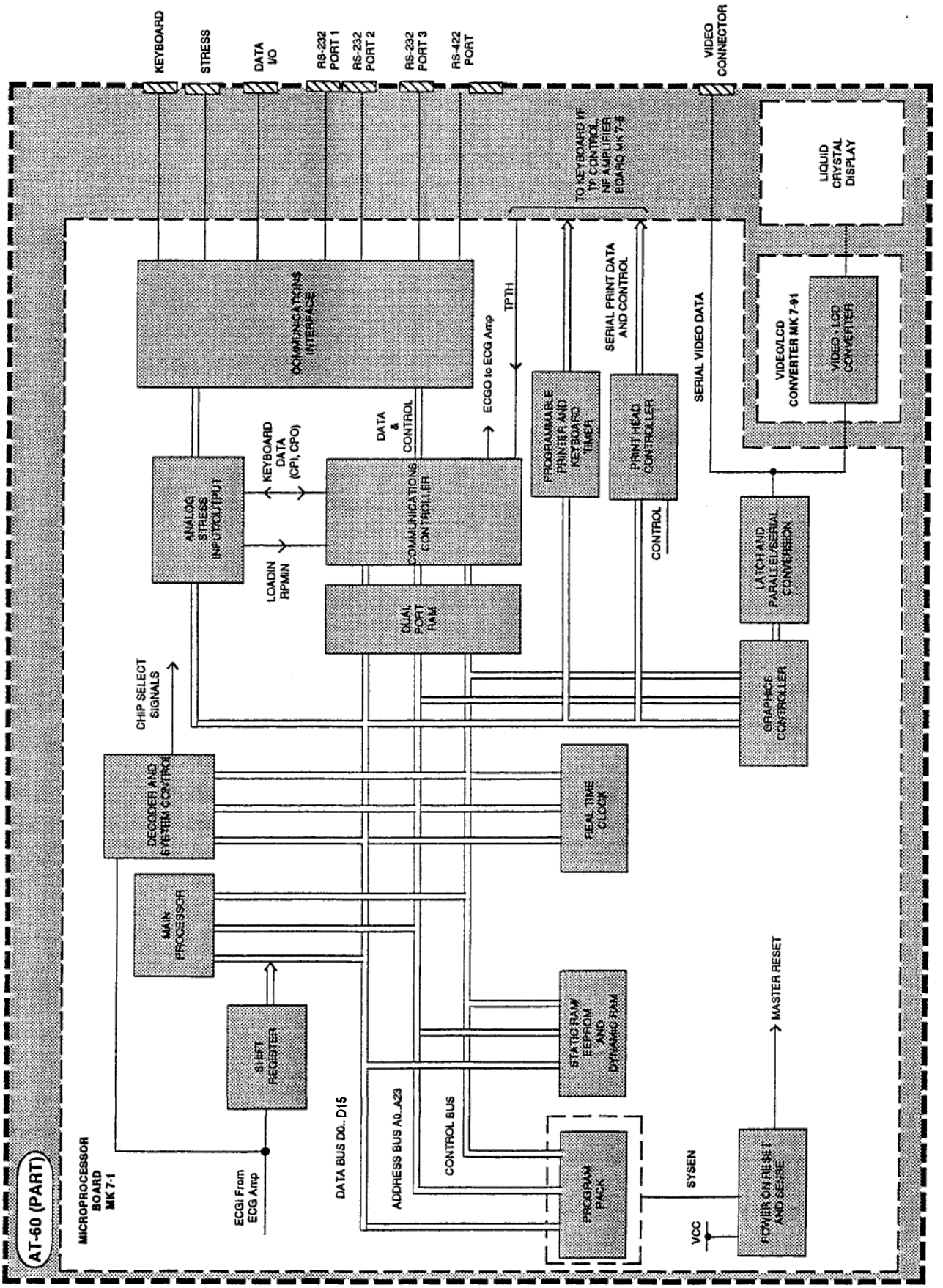
The + 17 V supply is monitored by U14B. A voltage greater than 15 V means mains operation, U14B is switched on and the Battery LED is disabled. When the voltage is less than, or equal to +15 V, U14B is switched off and the BATTOP active signal (+1.2 V) is gated with the output of a battery low detection circuit (U11B). When a battery low condition is sensed (approximately 10 V) a 2 Hz oscillator (C87) is gated with the BATTOP signal to make the Battery LED flash.

Operational Amplifier U11C monitors +UP with reference to +5 V When +UP drops below approximately +9.0 V BATTDOWN is active low and the unit is switched off (see above).

A delay circuit, formed by U11D and associated components, is incorporated into the Battery voltage detection circuits. The delay is necessary to prevent the BATTLOW or BATTDOWN signals becoming active during peak power consumption (for example when printing) which could cause the Battery LED to flicker, or even switch the unit off. The delay circuit temporarily compensates (with capacitor C90) for the voltage drop in +UP when power peaks occur.

Overvoltage Detection

Comparator U11A monitors the +24 V, +17 V, + 12 V and +5 V supplies via resistive voltage dividers so that a voltage of approximately + 4.8 V is present on the negative input with a reference voltage on the positive input of +4.97 V. If any of the monitored supplies goes high, the negative input goes higher than 5 V, and thus the OVERVOLTAGE signal is active low. The -24 V is monitored in the same way, connected to the positive input of the comparator.



CPU, Communication Control and LCD - Functional Block Diagram

CPU, Communication Control and LCD

CPU

Overall control and coordination of all circuits and all peripherals, is by the main processor (U56) situated on the Microprocessor Board. The CPU used is the 68000 and it works in conjunction with a dedicated gate array IC (U60). The main functions of the gate array circuit are as follows:

- To decode the address bus (A17 to A23) and generate the chip select (CS) signals for the memory and the peripherals. There are 20 chip select signals generated which include the following:
    - CSCC Chip Select Communication Controller
    - CSSTOR Chip Select Storage Controller
    - CSEE Chip Select for the EEPROM
- To generate interrupt priority signals (IPL0, IPL1, IPL2) for the main processor - the highest priority interrupt is `7' the lowest `1'.
- To generate the row address strobe (RAS), column address strobe (CAS) and address multiplex control signals for the Dynamic RAM.
- To synchronize the clock of the (asynchronous) ECG input signal.

Memory

Program Pack

The Program Pack comprises two EPROM chips and a DSP (digital signal processor). The DSP is used for real time processing of the ECG signal as follows:

- QRS detection
- Filtering (Myogram, Mains, Baseline)
- Lead calculation (I, II .. etc)

A 20 MHz oscillator provides the clock input for the DSP. Communication between the main CPU and the DSP is via a 16-bit parallel port integral in the DSP.

The EPROM chips contains the AT-60 software. The EPROMs each have 256 or 512 kByte of memory which is addressed by Address lines A0 to A20 and enabled by the EPROM CS signal.

Dynamic RAM

The Dynamic RAM comprises four 1 Mbyte RAM modules. The RAM control signals are generated by the gate array (U60). The RAM data is transparently refreshed via CAS before RAS control protocol at approximately 1kHz. The Dynamic RAM stores the following data:

- Printer pixel pattern
- Printer text data
- Stress test ECG data
- Rhythm ECG data

CPU, Communication Control and LCD (cont.)

Static RAM and EEPROM

The two128k RAM chips (U37, U38) are addressed via address lines A0 to A19 and enabled by the CSSRAM signal. The 64k EEPROM chip (U42) shares an enable signal with the real time clock (U39). The EEPROM stores the parameter settings that are remembered when power is disconnected.

The static RAM stores the following:

- Last 10 seconds of ECG data
- Patient data

Communications Controller

The Communications Controller carries out the following functions:

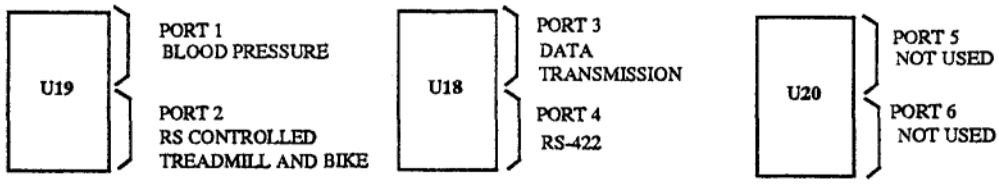
- Controls the serial ports
- Converts the incoming analog values from the stress connector to digital and vice versa.
- Provides synchronization of the peripheral devices with the CPU
- Reads the data from the external keyboard

The communications controller comprises a single chip processor ((U15) H8/532) with built in RAM and ROM to control the serial interfaces and the external keyboard, Stress and Data I/O ports. Data between the Communications Controller and the CPU, is via a dual port RAM (U16) which acts as a data buffer. It is selected by the CSCC signal.

The inputs to the A/D converter of the communications controller processor are as follows:

- Speed/load
- Elevation
- Temperature signal from the thermal print head.

Communication over the RS ports is via three Dual Communication Interface Controllers. Each of the controllers monitors two RS ports as follows:



The enable signals for the communication controllers are generated by U15 via a binary to octal converter (U17).

External keyboard input is buffered (U29A and U29B) and clocked into an 8-bit, tri-state shift register (U22). The data is read by U15 and, via the dual port RAM, passed to the CPU.

U15 also outputs the TREADMILL UP and TREADMILL DOWN signals (TMUP, TMDN) to control treadmill elevation via the Data I/O port.

CPU, Communication Control and LCD (cont.)

Analog Sress Input/Output

The analog input/output circuit comprises a digital/analog converter circuit and buffer circuits that carry out the following functions:

- Convert the control commands for any connected ergometric equipment (bikes or treadmills), to the required analog command signal - a 12-bit DAC produces the LOAD OUT signal (ERGO0). The output is 1V per 100 W.
- Buffers and scales the returned analog responses from the ergonomic equipment. The returned signals are:
  - LOAD IN (ERGO1) (also used for the treadmill speed input). The load signal is 100W = 1V,
  - RPM IN (ERGO 2) (also used for the treadmill elevation input). The RPM signal is 10 RPM = 1V, the elevation angle signal is 1V = 12°

  These signals, are converted to a digital signal by the A/D converter in the Communications Controller.

Thermal Print Head Controller

The Thermal Print Head Controller circuit comprises programmable generic array logic (GAL) chips and latch buffers. Data to be printed is presented on the data bus and strobed through first in, first out (FIFO) memories (U30 and U31) in two bytes (lower - D0 to D7, upper D8 to D15). The 10 input, 8 output GALs are programmed to serialize data from the FIFOs memories and send it in the required format for the printer. To ensure a superior quality print the print head data is 'cycled' so that each pulse is repeated eight times. This is carried out by FIFO memory U35.

TPD is the print head serial data signal, TPS0 and TPS1 are printer strobes, and TP clock is the 4 MHz serial data clock. The output to the printer is synchronized with the 1.9 kHz clock. The temperature control for the print head is set by the TPDUR signal (thermal print duration from the programmable timer), which is strobed by signal TGATE (6kHz).

Programmable Printer Timer and Beeper

The Programmable Timer circuit generates the variable timing pulses required by the Top Assembly circuits. The Timer circuit comprises U40 and U41 which decode the timing instructions from the CPU encoded on the data bus. The Timers are accessed by the CSEE signal. The timing signals produced are as follows:

- MCLK — The printer motor clock. The faster the speed of the motor the faster the paper feed.
- ISYS — A general purpose timing clock of 2 kHz, used as system interrupt (determines sampling rate, printing rate etc.)
- TPDUR — The duration that the print head is heated. This is calculated, by the CPU, from the resistance of the print head and the measured ambient temperature.
- ALBEEP, KBBEEP — Audio signals for the alarm and keyboard beeper.

The timers are addressed by address line A1 and A2 to select the required timing. The frequency of the master clock input, is 5 MHz.

CPU, Communication Control and LCD (cont.)

Graphics Controller

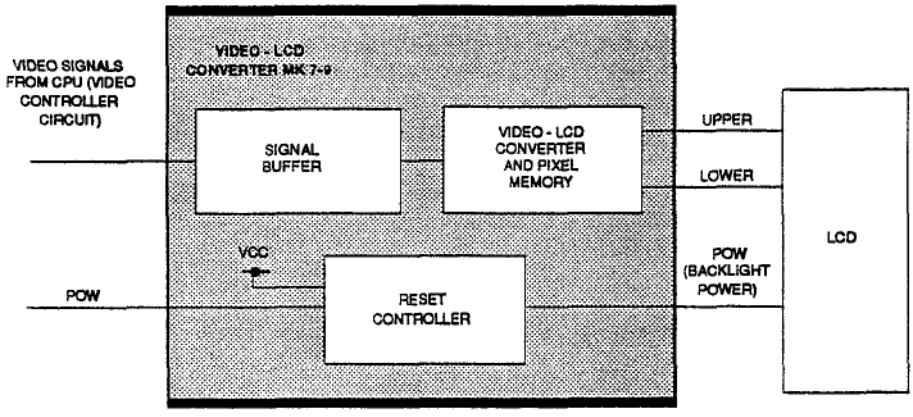
A VGA standard signal (480 rows with 640 pixels/row with a horizontal sync of approximately 31.8 kHz and a vertical sync of 60 Hz), is generated by a graphics processor chip (U43). The video controller also generates all the necessary protocol signals (VSYNC, HSYNC etc).

The parallel data output of the video controller is fed to two 8-bit shift registers (U47 and U48) which together convert the 16-bit parallel output from the video controller to the required serial video output. Two RAM chips (U44 and U45), latch the pixel pattern and allow picture freeze when required. The serial video output signal is gated with signal SCINV to invert the screen image (changes the LCD to white on black image), when set.

The GAL (U46) is used for decoding certain control and enable signals from the video controller to the RAM latch.

Video - LCD Converter

The Video/LCD Converter chip (U3) generates all the timing and strobe signals required by the LCD and converts the serial video signal into the correct format. Four upper and four lower control and data signals are output to the LCD along with two clock signals. A working memory for the converter chip is provided (U4).



Video - LCD Converter - Functional Block Diagram

A power monitor (U5), associated with this circuit, monitors the +5V rail. If the voltage drops below 4.75V, the 24V LCD drive voltage is cut and the display cannot be seen. This is a double safety feature to prevent a display being seen if the converter is not working correctly and the integrity of the displayed data cannot be guaranteed.

Power On Reset

The Power on reset circuit comprises Chip U63 and associated components. The circuit controls the master reset of the CPU. This circuit has three functions as follows:

- Provides a delay on initial switch on to ensure that the power supply is fully stabilised and to give the 200ms reset time required by the 68000 processor.
- Ensures that the system is inoperative and in Reset mode when the SYSEN indicates that the Program Pack is not present
- Disables the unit if the +5V rail drops below +4.75V.

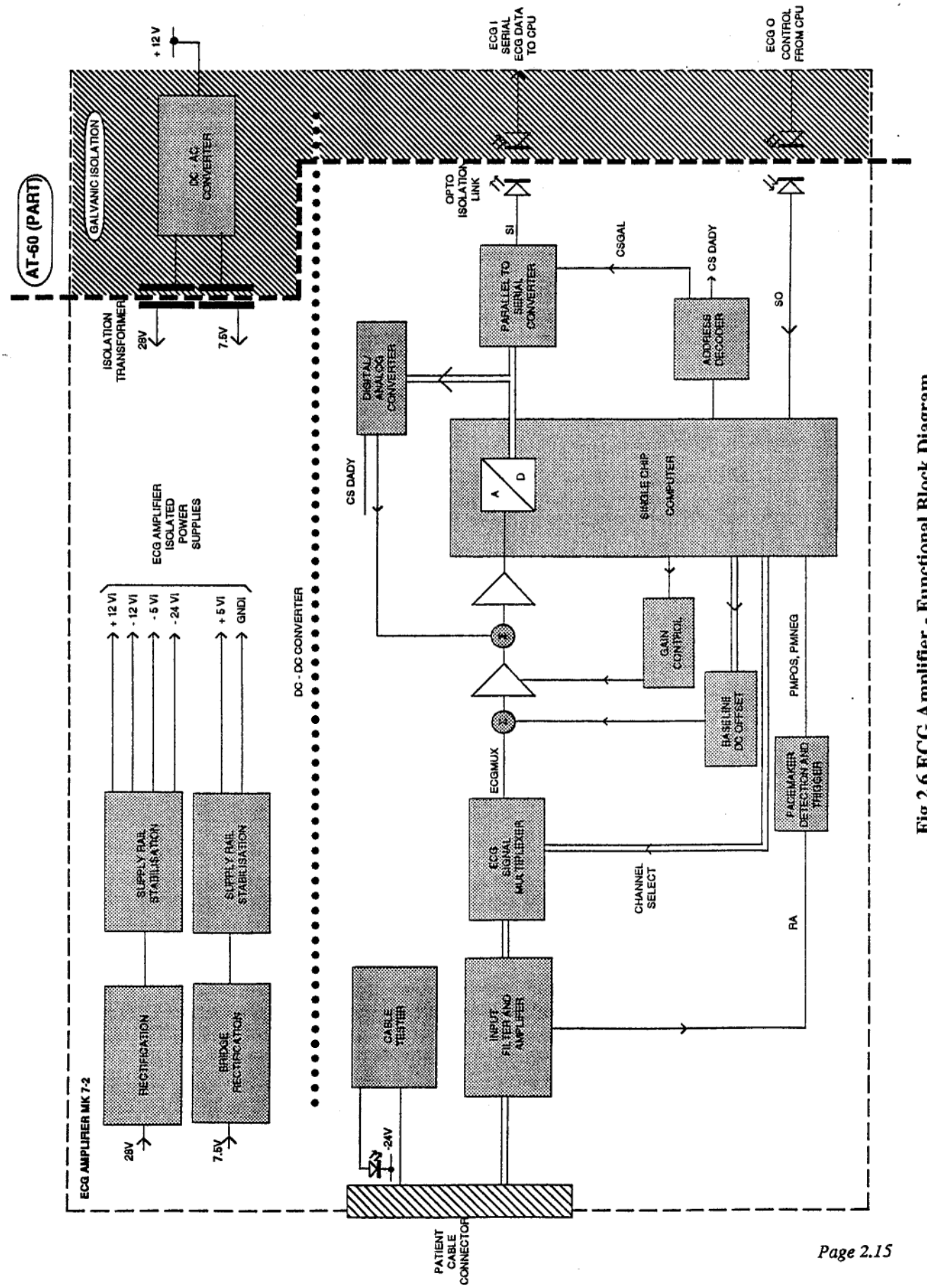


Fig 2.6 ECG Amplifier - Functional Block Diagram

ECG Amplifier

ECG Isolated Power Supplies

The DC/DC converter circuit produces all the isolated power voltages required by the ECG Amplifier circuit. The +12V rail from Power Supply MK-7-6 is applied to isolation transformer U2 via a pulsing circuit. The pulsing circuit comprises a 125kHz oscillator divided by two, which via Schmitt triggers switches MOS FETs Q3 and Q4. This gives a pulsed, 180° phase shifted input on the two primary windings of the isolation transformer.

The two secondary windings of the isolation transformer produce 28V and 7.5V respectively. A Schotky diode and capacitor network produce the +12V, -12V and -24V isolated supplies. A linear regulator (U5) generates the -5V supply from the isolated -12V supply.

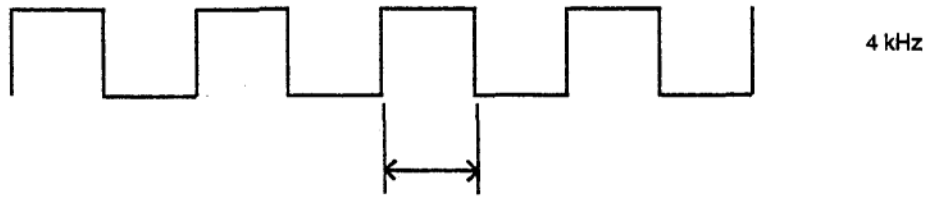
The +5V isolated supply is generated from the 7.5V secondary winding. A bridge rectifier produces approximately +7V which is applied to a FET. The FET is controlled by an operational-amp and transistor circuit so that it acts as a variable resistor to stabilise and produce a +5V supply.

Servicing Note: When taking measurements always ensure that the isolated ground is used for reference.

ECG Signal

The incoming ECG signals RA, LA, and C1 to C9 are 41kHz low-pass filtered and applied to non-inverting operational-amps giving a gain of 11. The signals are further low pass filtered (1.6kHz) and amplified by 3 before being applied to the multiplexer.

The multiplexer enable signal is 4kHz with the output duration of each sampled lead approximately 20 microseconds.



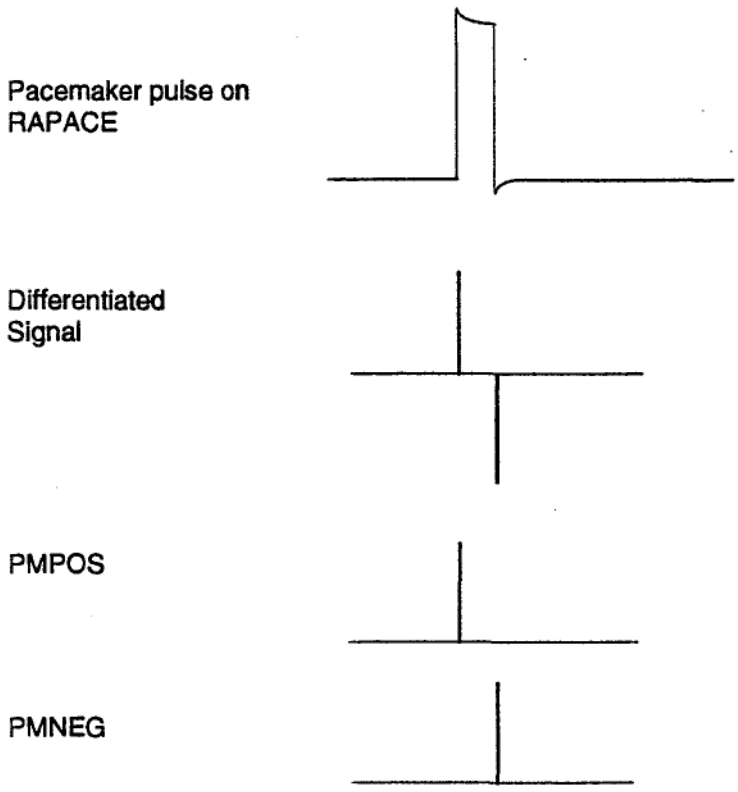
The multiplexed ECG signal is base line compensated. The base line compensation is set by the ECG processor and converted to an analog signal by a DAC (U20). The maximum compensation is ± 300 mV. A gain control is also incorporated for the multiplexed ECG signal, and set by the processor. This gain is selectable to 2.5, 5, or 10.

The signal is then passed to a summing circuit where the last sample value from the D/A converter (U21) is subtracted from the present sample value. The resultant is the difference of the actual sample and the previous sample. The resulting voltage is analog to digital converted by the ECG processor and output to the CPU via a multiplexer and GAL circuit (U23, U26) and opto isolators.

Pacemaker Trigger

The RA lead is fed, before it is filtered, to the pacemaker detection circuit. The RAPACE signal from the patient is differentiated and fed to the ECG processor. The negative and positive pulses (PMNEG and PMPOS) indicate the start and end slope of the pacemaker pulse. From the signals the CPU can calculate the timing of the pacemaker pulse for display (software option).

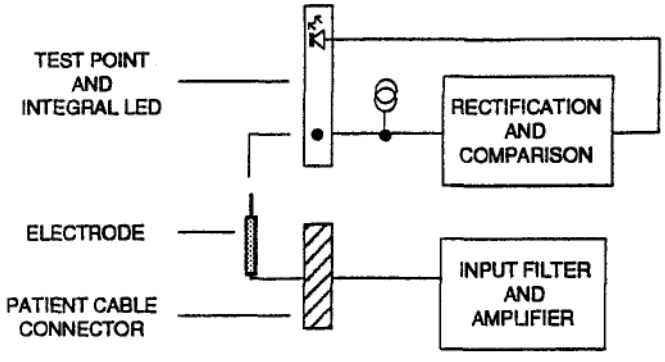
ECG Amplifier (cont.)

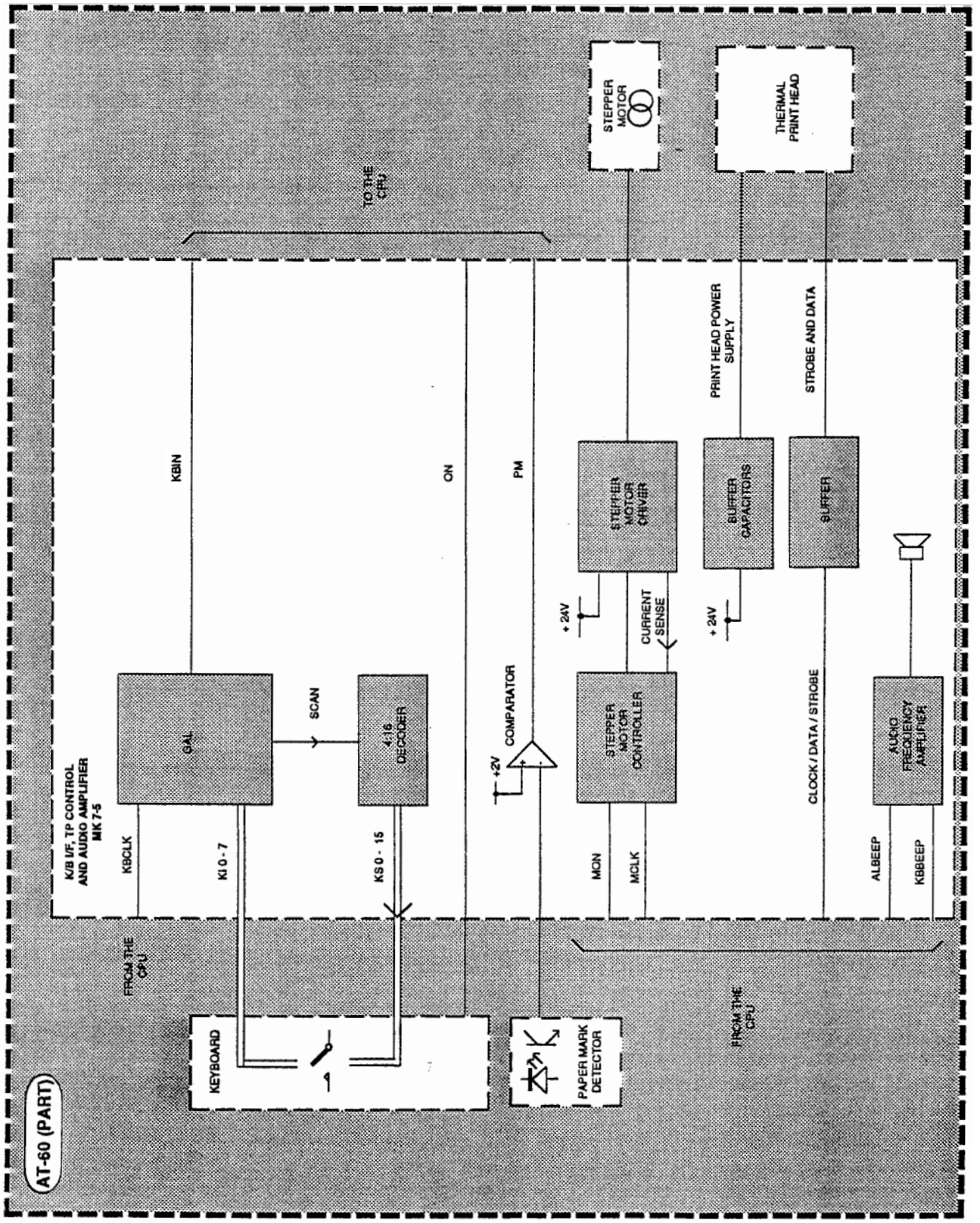


Cable Tester

The cable tester circuit checks the resistance of an individual lead in the patient cable. The resistance of the lead must be between 10KOhms and 1MOhms.

The cable tester comprises a 3.3kHz oscillator and comparator circuit. The oscillator is connected to the test point and when a lead is connected to the test point, the potential on the lead (from the input filter and amplifier circuit) alters the waveform. The waveform is rectified and, via a comparator (U1B) lights the LED. The comparison voltage at U1B is 1.45V and the generated waveform is at a base level of approximately -17V with an oscillation of 5V.





K/B I/F, TP Control, and Audio Frequency Amplifier - Functional Block Diagram

Keyboard Interface, Thermal printer Control and audio Amplifier

Keyboard Interface

The keyboard comprises a switch matrix which is periodically scanned by the CPU. The Keyboard clock signal is generated by the CPU to control a GAL (U4), The GAL generates 4 scan control signals which, via a 4 to 16 decoder, generate 16 keyboard scan signals. When a key is pressed and the switch made, the KI signal is active and, via the GAL the serial key data is passed to the CPU.

Thermal Printer Control

The Thermal Printer stepper motor is controlled by stepper motor controller U6. The MON signal from the processor is the enable signal for the controller and the MCLK signal sets the speed; 209Hz gives a paper speed of 2.5 mm/s, 2.09kHz gives a paper speed of 25 mm/s. The driver circuit incorporates a current sense circuit. If the current drawn is greater than 100 mA the sense signal is active and the motor stopped. Protection diodes on the output lines protect against spikes from the stepper motor.

The printer data, the strobe and the clock signals are buffered by U9. The strobe frequencies (TPS0 and TPS1) are 2kHz, the clock (TPCLCK) is 4MHz, and the latch frequency (TPL) is 2kHz.

Because of the high power peaks drawn by the TPH, reservoir capacitors on the +24V rail ensure a stable supply to the thermal print head.

The paper mark detector is an opto sense circuit. The output from the detector is fed to an operational amplifier (U8) to set the PM signal when a paper mark is detected.

Audio Frequency Amplifier

The audio frequency amplifier circuit amplifies the KBBEEP or the ALBEEP signal from the CPU via the timer circuit.

Chapter 3
Fault Diagnosis

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Introduction

The purpose of this chapter is to provide fault-finding procedures that will quickly and efficiently identify a fault on an AT-60 to a specific module. The fault-finding procedures are designed so that test equipment is kept to a minimum.

An initial fault diagnosis chart is provided detailing all the general fault indications that may occur. When this is followed it will indicate the module where the fault lies or specify a further fault-finding procedure. When more than one module is stated, the first module given is the one most likely to contain the fault. If the fault is not found on the first module, the other modules should be checked in the order given.

If the initial fault-finding chart does not indicate the area where the fault exists, re-check all the settings and parameters that have been entered (for the particular task that fails). If these are correct, check the software. If this is correct suspect external connections.

When a key operation or menu selection is required when carrying out the functional checks after replacement, the key sequence required is given in parenthesis '<>'. The character(s) given in parenthesis is the actual character(s) printed on the key. When a key sequence is provided it must be followed in the order given. For example the key sequence to give the Macro screen is:

<FNCT> <2> <ENTER>

This requires that the Function key on the keypad is pressed, followed by the '2' key followed by the Return (or Enter) key.

WARNINGS

MAINS POWER IS PRESENT WHEN THE UNIT COVER IS REMOVED. CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED WITH MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

THE AT-60 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS. WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT. PERSONNEL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS. ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

Test Equipment

The following proprietary and dedicated test equipment is the minimum that is required to fault find and carry out any board checks and adjustments, on the AT-60.

The list of proprietary equipment is not comprehensive. Recommendations of suitable proprietary test equipment can be obtained from the Schiller Service Department

Dedicated Test Equipment

◊ RS Test Cable Assembly required for the RS self test

In addition to the above a Schiller patient cable (Schiller Number 2.400011) is required when carrying out simulated ECG tests.

Proprietary Test Equipment/Tools

◊ ECG Emulator, eg Phantom 320*

◊ Oscilloscope

◊ Digital Multimeter*

◊ Stabilised Power Supply

◊ Standard tool kit with a selection of cross-bladed and flat-bladed screwdrivers, Pliers and general tools*

◊ Soldering Iron

◊ VGA Monitor

* Indicates Essential Equipment for basic AT-60 fault finding

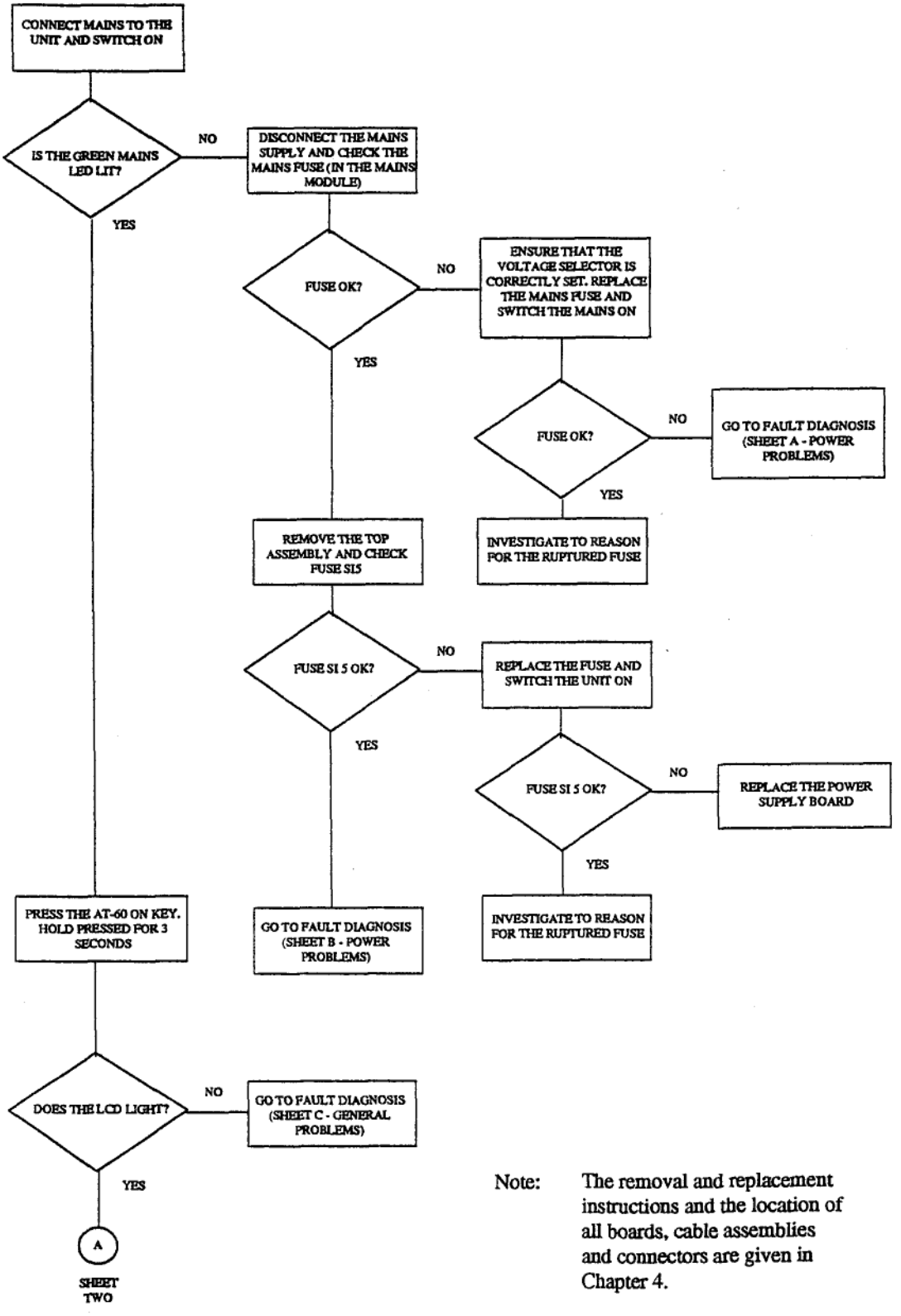
Special Tools / Equipment

DESCRIPTION	PURPOSE	PART NUMBER
HEXAGONAL CROSS-BLADED SCREWDRIVER	REMOVAL AND REPLACEMENT OF THE PRINT HEAD	SCHILLER NUMBER 4.950074. MANUFACTURED BY WERA, NUMBER - WERA 367 TX 210180

Fault Diagnosis

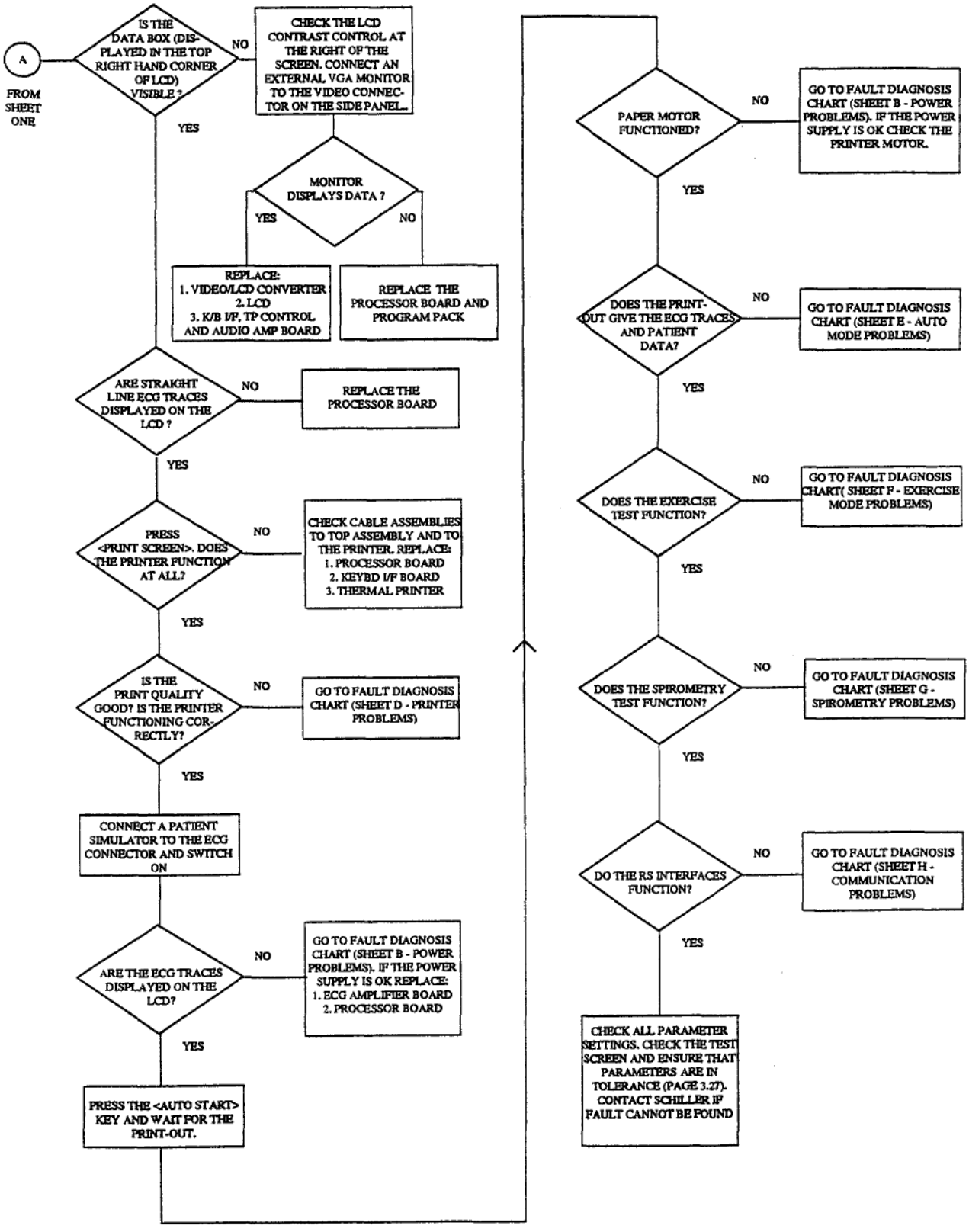
Use the fault finding charts and procedures on the following pages to indicate a faulty area or module. In most cases the fault finding charts should indicate the most likely faulty area.

When a possible faulty module is indicated by the fault finding charts, the module must be replaced. When a module has been replaced specific test parameters and setting-up of the module may be applicable. The Removal and Replacement instructions for all replaceable modules, along with any set-up or check procedures required, are given in Chapter 4.

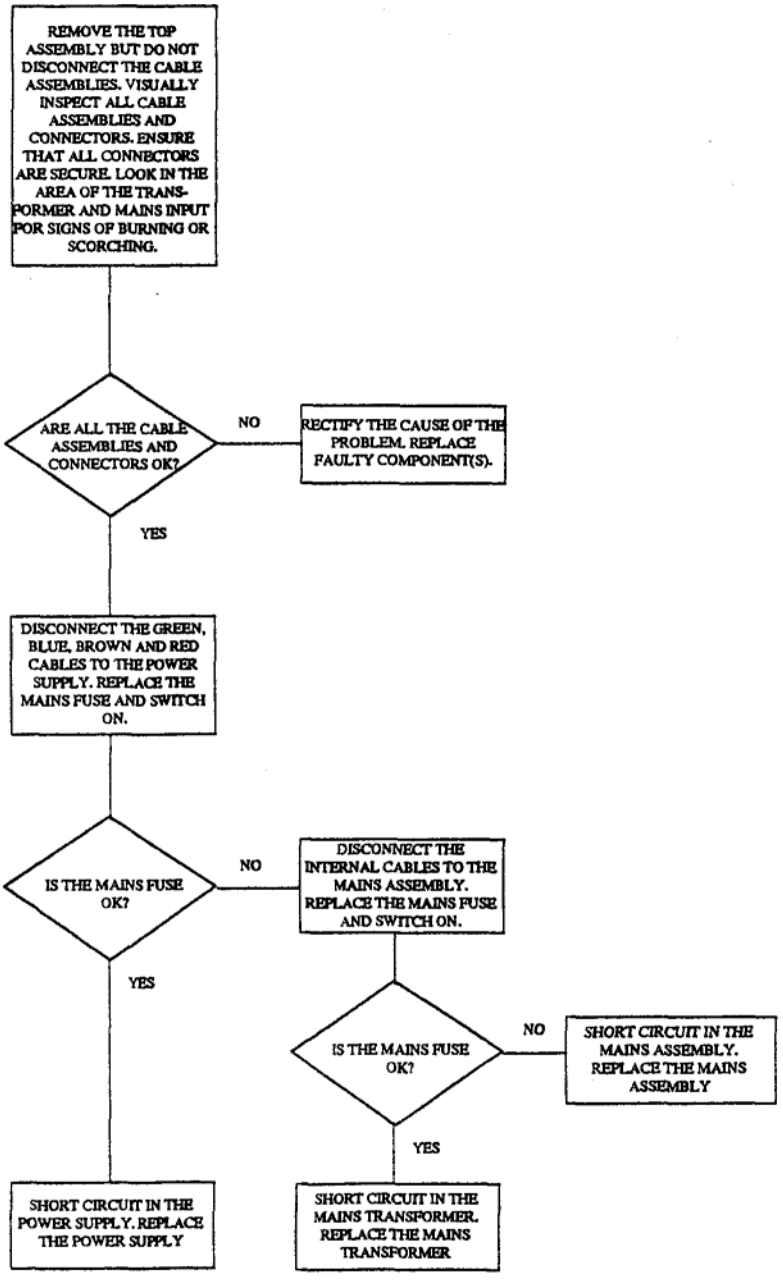

CONNECT MAINS TO THE UNIT AND SWITCH ON
IS THE GREEN MAINS LED LIT?
NO
DISCONNECT THE MAINS SUPPLY AND CHECK THE MAINS FUSE (IN THE MAINS MODULE)
YES
FUSE OK?
NO
ENSURE THAT THE VOLTAGE SELECTOR IS CORRECTLY SET. REPLACE THE MAINS FUSE AND SWITCH THE MAINS ON
YES
FUSE OK?
NO
GO TO FAULT DIAGNOSIS (SHEET A - POWER PROBLEMS)
YES
REMOVE THE TOP ASSEMBLY AND CHECK FUSE SI5
INVESTIGATE TO REASON FOR THE RUPTURED FUSE
FUSE SI 5 OK?
NO
REPLACE THE FUSE AND SWITCH THE UNIT ON
YES
FUSE SI 5 OK?
NO
REPLACE THE POWER SUPPLY BOARD
YES
PRESS THE AT-60 ON KEY. HOLD PRESSED FOR 3 SECONDS
GO TO FAULT DIAGNOSIS (SHEET B - POWER PROBLEMS)
INVESTIGATE TO REASON FOR THE RUPTURED FUSE
DOES THE LCD LIGHT?
NO
GO TO FAULT DIAGNOSIS (SHEET C - GENERAL PROBLEMS)
YES
A
SHEET TWO

Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Initial Fault Diagnosis Chart (Sheet 1)

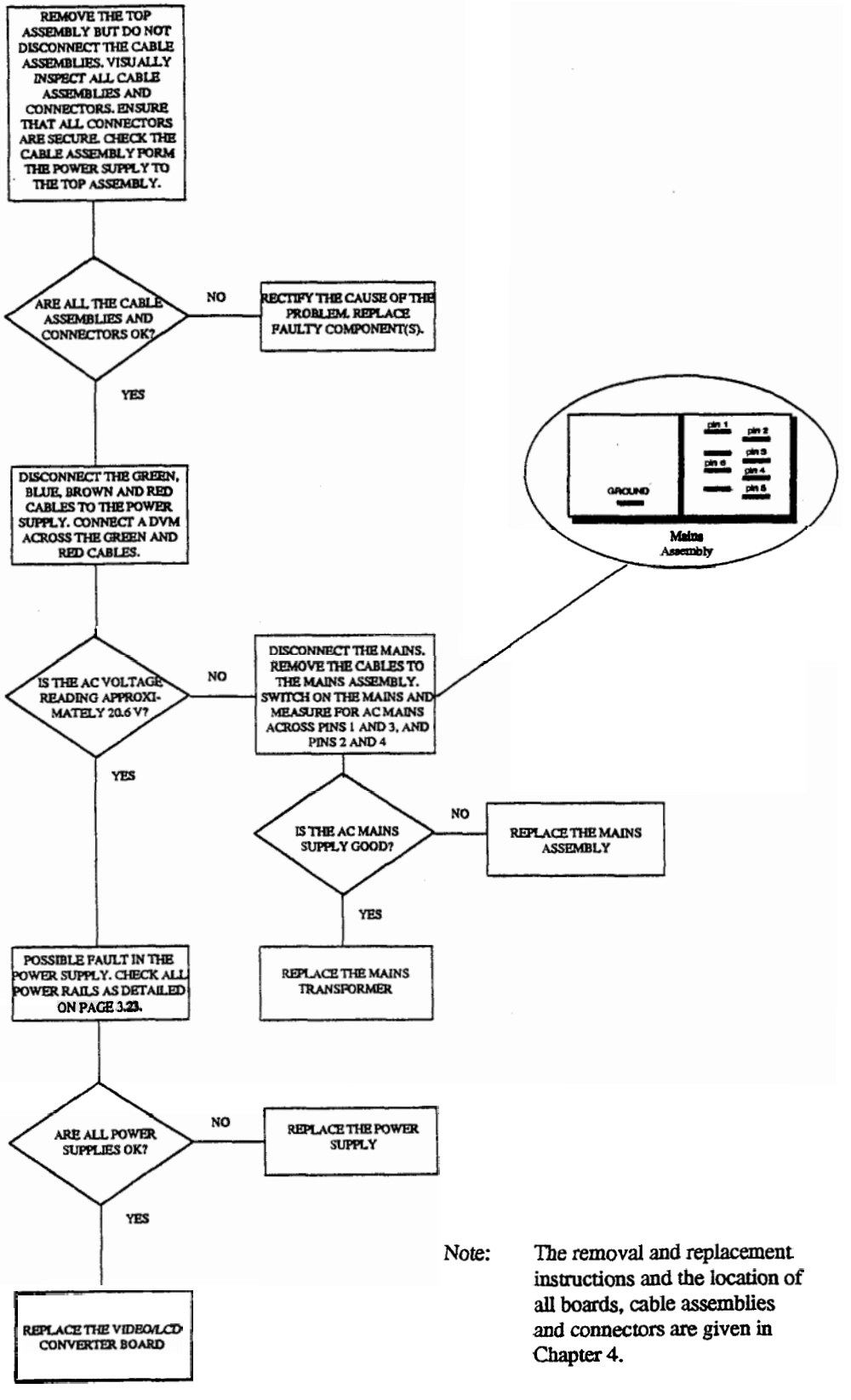

A
FROM SHEET ONE
IS THE DATA BOX (DISPLAYED IN THE TOP RIGHT HAND CORNER OF LCD) VISIBLE ?
NO
YES
CHECK THE LCD CONTRAST CONTROL AT THE RIGHT OF THE SCREEN. CONNECT AN EXTERNAL VGA MONITOR TO THE VIDEO CONNECTOR ON THE SIDE PANEL.
MONITOR DISPLAYS DATA ?
YES
NO
REPLACE:
1. VIDEO/LCD CONVERTER
2. LCD
3. K/B I/F, TP CONTROL AND AUDIO AMP BOARD
REPLACE THE PROCESSOR BOARD AND PROGRAM PACK
ARE STRAIGHT LINE ECG TRACES DISPLAYED ON THE LCD ?
NO
REPLACE THE PROCESSOR BOARD
YES
PRESS <PRINT SCREEN>. DOES THE PRINTER FUNCTION AT ALL?
NO
CHECK CABLE ASSEMBLIES TO TOP ASSEMBLY AND TO THE PRINTER. REPLACE:
1. PROCESSOR BOARD
2. KEYBD I/F BOARD
3. THERMAL PRINTER
YES
IS THE PRINT QUALITY GOOD? IS THE PRINTER FUNCTIONING CORRECTLY?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET D - PRINTER PROBLEMS)
YES
CONNECT A PATIENT SIMULATOR TO THE ECG CONNECTOR AND SWITCH ON
ARE THE ECG TRACES DISPLAYED ON THE LCD?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET B - POWER PROBLEMS). IF THE POWER SUPPLY IS OK REPLACE:
1. ECG AMPLIFIER BOARD
2. PROCESSOR BOARD
YES
PRESS THE <AUTO START> KEY AND WAIT FOR THE PRINT-OUT.
PAPER MOTOR FUNCTIONED?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET B - POWER PROBLEMS). IF THE POWER SUPPLY IS OK CHECK THE PRINTER MOTOR.
YES
DOES THE PRINT-OUT GIVE THE ECG TRACES AND PATIENT DATA?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET E - AUTO MODE PROBLEMS)
YES
DOES THE EXERCISE TEST FUNCTION?
NO
GO TO FAULT DIAGNOSIS CHART(SHEET F - EXERCISE MODE PROBLEMS)
YES
DOES THE SPIROMETRY TEST FUNCTION?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET G - SPIROMETRY PROBLEMS)
YES
DO THE RS INTERFACES FUNCTION?
NO
GO TO FAULT DIAGNOSIS CHART (SHEET H - COMMUNICATION PROBLEMS)
YES
CHECK ALL PARAMETER SETTINGS. CHECK THE TEST SCREEN AND ENSURE THAT PARAMETERS ARE IN TOLERANCE (PAGE 3.27). CONTACT SCHILLER IF FAULT CANNOT BE FOUND

AT-60 Initial Fault Diagnosis Chart (Sheet 2)


REMOVE THE TOP ASSEMBLY BUT DO NOT DISCONNECT THE CABLE ASSEMBLIES. VISUALLY INSPECT ALL CABLE ASSEMBLIES AND CONNECTORS. ENSURE THAT ALL CONNECTORS ARE SECURE. LOOK IN THE AREA OF THE TRANS-FORMER AND MAINS INPUT FOR SIGNS OF BURNING OR SCORCHING.
ARE ALL THE CABLE ASSEMBLIES AND CONNECTORS OK?
NO
RECTIFY THE CAUSE OF THE PROBLEM. REPLACE FAULTY COMPONENT(S).
YES
DISCONNECT THE GREEN, BLUE, BROWN AND RED CABLES TO THE POWER SUPPLY. REPLACE THE MAINS FUSE AND SWITCH ON.
IS THE MAINS FUSE OK?
NO
DISCONNECT THE INTERNAL CABLES TO THE MAINS ASSEMBLY. REPLACE THE MAINS FUSE AND SWITCH ON.
YES
IS THE MAINS FUSE OK?
NO
SHORT CIRCUIT IN THE MAINS ASSEMBLY. REPLACE THE MAINS ASSEMBLY
YES
SHORT CIRCUIT IN THE POWER SUPPLY. REPLACE THE POWER SUPPLY
SHORT CIRCUIT IN THE MAINS TRANSFORMER. REPLACE THE MAINS TRANSFORMER

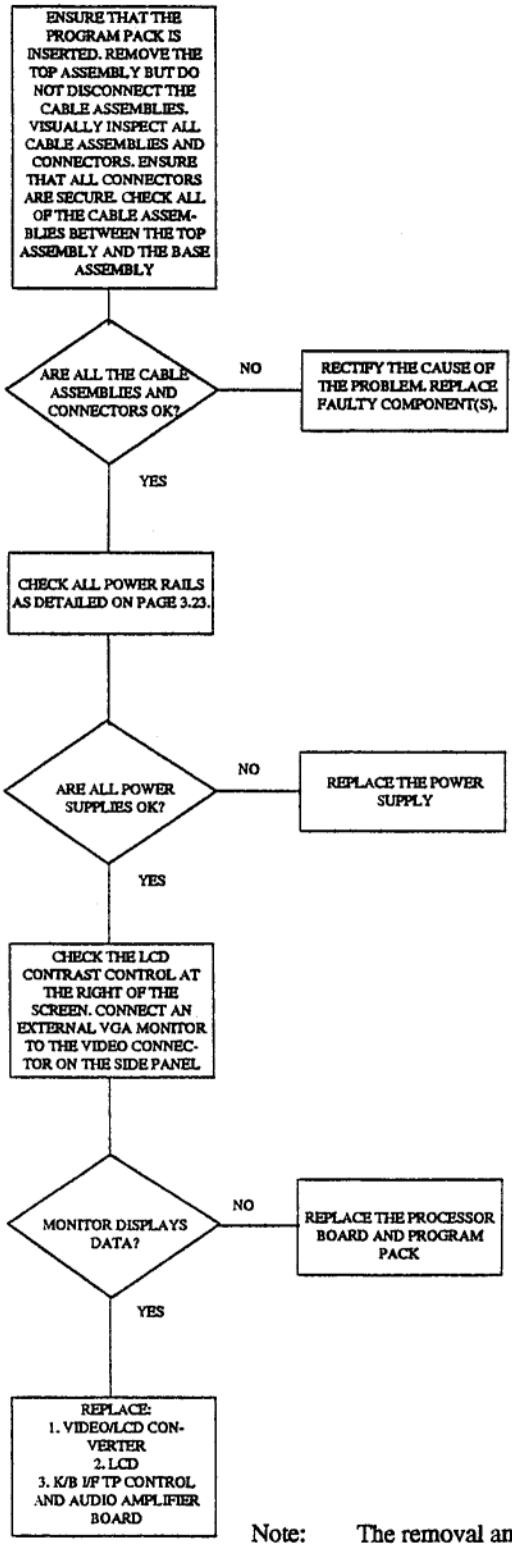
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Fault Diagnosis Chart (Sheet A - Power Problems)


REMOVE THE TOP ASSEMBLY BUT DO NOT DISCONNECT THE CABLE ASSEMBLIES. VISUALLY INSPECT ALL CABLE ASSEMBLIES AND CONNECTORS. ENSURE THAT ALL CONNECTORS ARE SECURE. CHECK THE CABLE ASSEMBLY FORM THE POWER SUPPLY TO THE TOP ASSEMBLY.
ARE ALL THE CABLE ASSEMBLIES AND CONNECTORS OK?
NO
RECTIFY THE CAUSE OF THE PROBLEM. REPLACE FAULTY COMPONENT(S).
YES
DISCONNECT THE GREEN, BLUE, BROWN AND RED CABLES TO THE POWER SUPPLY. CONNECT A DVM ACROSS THE GREEN AND RED CABLES.
IS THE AC VOLTAGE READING APPROXIMATELY 20.6 V?
NO
DISCONNECT THE MAINS. REMOVE THE CABLES TO THE MAINS ASSEMBLY. SWITCH ON THE MAINS AND MEASURE FOR AC MAINS ACROSS PINS 1 AND 3, AND PINS 2 AND 4
YES
IS THE AC MAINS SUPPLY GOOD?
NO
REPLACE THE MAINS ASSEMBLY
YES
POSSIBLE FAULT IN THE POWER SUPPLY. CHECK ALL POWER RAILS AS DETAILED ON PAGE 3.23.
REPLACE THE MAINS TRANSFORMER
ARE ALL POWER SUPPLIES OK?
NO
REPLACE THE POWER SUPPLY
YES
REPLACE THE VIDEO/LCD CONVERTER BOARD
GROUND
pin 1
pin 2
pin 3
pin 4
pin 5
pin 6
Mains Assembly

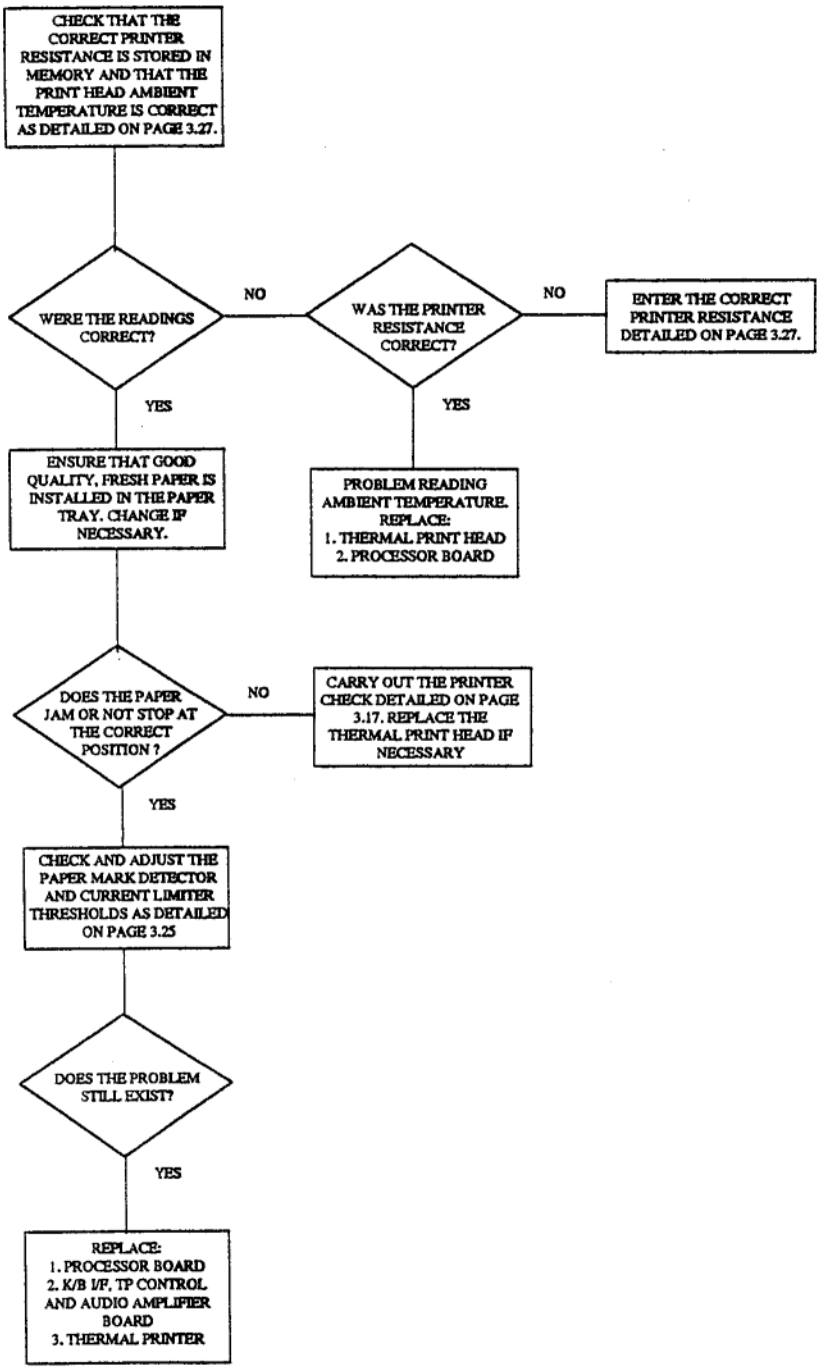
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Fault Diagnosis Chart (Sheet B - Power problems)


ENSURE THAT THE PROGRAM PACK IS INSERTED. REMOVE THE TOP ASSEMBLY BUT DO NOT DISCONNECT THE CABLE ASSEMBLIES. VISUALLY INSPECT ALL CABLE ASSEMBLIES AND CONNECTORS. ENSURE THAT ALL CONNECTORS ARE SECURE. CHECK ALL OF THE CABLE ASSEMBLIES BETWEEN THE TOP ASSEMBLY AND THE BASE ASSEMBLY
ARE ALL THE CABLE ASSEMBLIES AND CONNECTORS OK?
NO
RECTIFY THE CAUSE OF THE PROBLEM. REPLACE FAULTY COMPONENT(S).
YES
CHECK ALL POWER RAILS AS DETAILED ON PAGE 3.23.
ARE ALL POWER SUPPLIES OK?
NO
REPLACE THE POWER SUPPLY
YES
CHECK THE LCD CONTRAST CONTROL AT THE RIGHT OF THE SCREEN. CONNECT AN EXTERNAL VGA MONITOR TO THE VIDEO CONNECTOR ON THE SIDE PANEL
MONITOR DISPLAYS DATA?
NO
REPLACE THE PROCESSOR BOARD AND PROGRAM PACK
YES
REPLACE:
1. VIDEO/LCD CONVERTER
2. LCD
3. K/B I/F TP CONTROL AND AUDIO AMPLIFIER BOARD

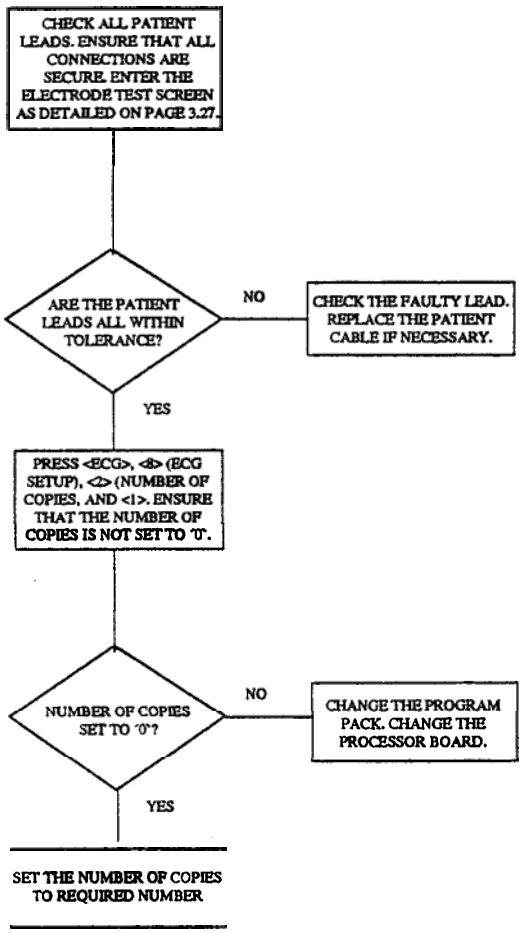
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Fault Diagnosis Chart (Sheet C - General Problems)

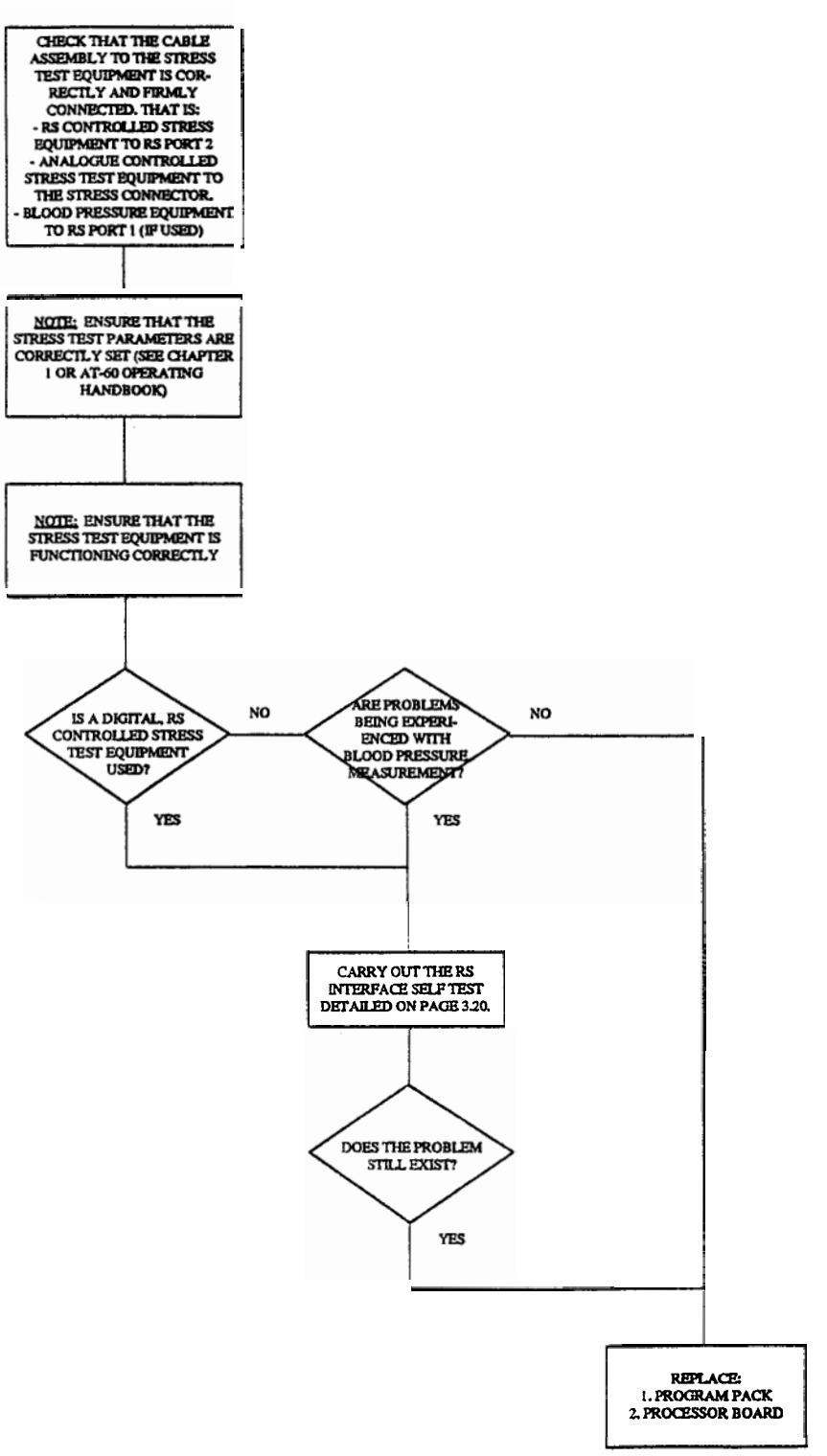

CHECK THAT THE CORRECT PRINTER RESISTANCE IS STORED IN MEMORY AND THAT THE PRINT HEAD AMBIENT TEMPERATURE IS CORRECT AS DETAILED ON PAGE 3.27.
WERE THE READINGS CORRECT?
NO
WAS THE PRINTER RESISTANCE CORRECT?
NO
ENTER THE CORRECT PRINTER RESISTANCE DETAILED ON PAGE 3.27.
YES
YES
ENSURE THAT GOOD QUALITY, FRESH PAPER IS INSTALLED IN THE PAPER TRAY. CHANGE IF NECESSARY.
PROBLEM READING AMBIENT TEMPERATURE. REPLACE:
1. THERMAL PRINT HEAD
2. PROCESSOR BOARD
DOES THE PAPER JAM OR NOT STOP AT THE CORRECT POSITION ?
NO
CARRY OUT THE PRINTER CHECK DETAILED ON PAGE 3.17. REPLACE THE THERMAL PRINT HEAD IF NECESSARY
YES
CHECK AND ADJUST THE PAPER MARK DETECTOR AND CURRENT LIMITER THRESHOLDS AS DETAILED ON PAGE 3.25
DOES THE PROBLEM STILL EXIST?
YES
REPLACE:
1. PROCESSOR BOARD
2. K/B I/F, TP CONTROL AND AUDIO AMPLIFIER BOARD
3. THERMAL PRINTER

Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

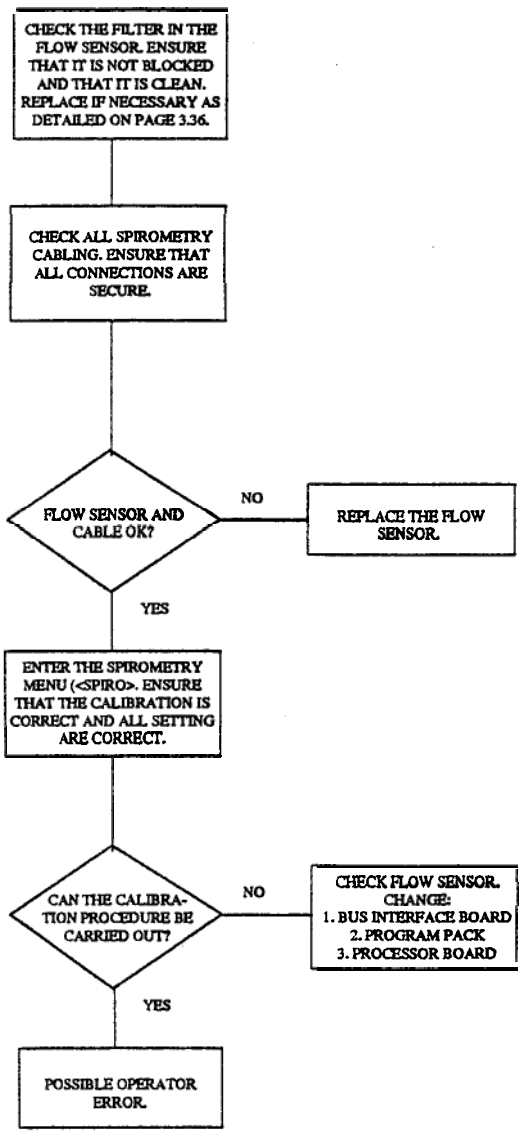
AT-60 Fault Diagnosis Chart (Sheet D- Printer Problems)


CHECK ALL PATIENT LEADS. ENSURE THAT ALL CONNECTIONS ARE SECURE. ENTER THE ELECTRODE TEST SCREEN AS DETAILED ON PAGE 3.27.
ARE THE PATIENT LEADS ALL WITHIN TOLERANCE?
NO
CHECK THE FAULTY LEAD. REPLACE THE PATIENT CABLE IF NECESSARY.
YES
PRESS <ECG>, <8> (ECG SETUP), <2> (NUMBER OF COPIES, AND <1>. ENSURE THAT THE NUMBER OF COPIES IS NOT SET TO '0'.
NUMBER OF COPIES SET TO '0'?
NO
CHANGE THE PROGRAM PACK. CHANGE THE PROCESSOR BOARD.
YES
SET THE NUMBER OF COPIES TO REQUIRED NUMBER

AT-60 Fault Diagnosis Chart (Sheet E - Auto Mode Problems)

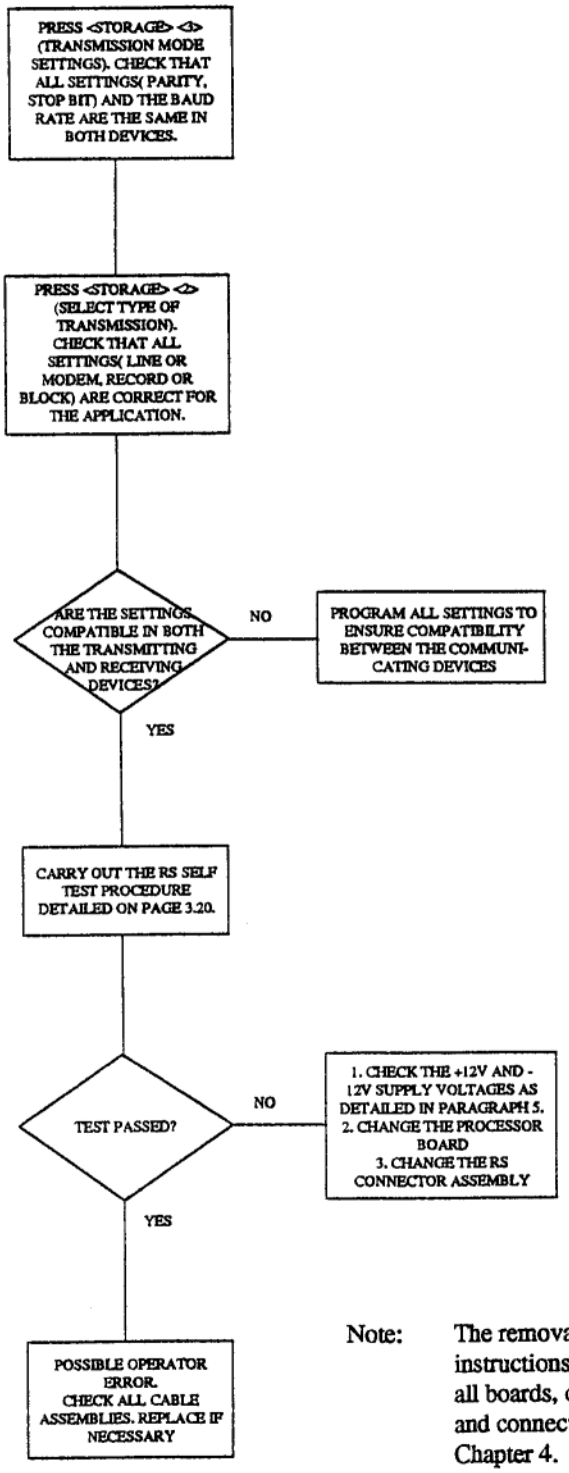

CHECK THAT THE CABLE ASSEMBLY TO THE STRESS TEST EQUIPMENT IS CORRECTLY AND FIRMLY CONNECTED. THAT IS:
- RS CONTROLLED STRESS EQUIPMENT TO RS PORT 2
- ANALOGUE CONTROLLED STRESS TEST EQUIPMENT TO THE STRESS CONNECTOR.
- BLOOD PRESSURE EQUIPMENT TO RS PORT 1 (IF USED)
NOTE: ENSURE THAT THE STRESS TEST PARAMETERS ARE CORRECTLY SET (SEE CHAPTER 1 OR AT-60 OPERATING HANDBOOK)
NOTE: ENSURE THAT THE STRESS TEST EQUIPMENT IS FUNCTIONING CORRECTLY
IS A DIGITAL, RS CONTROLLED STRESS TEST EQUIPMENT USED?
NO
YES
ARE PROBLEMS BEING EXPERIENCED WITH BLOOD PRESSURE MEASUREMENT?
NO
YES
CARRY OUT THE RS INTERFACE SELF TEST DETAILED ON PAGE 3.20.
DOES THE PROBLEM STILL EXIST?
YES
REPLACE:
1. PROGRAM PACK
2. PROCESSOR BOARD

AT-60 Fault Diagnosis Chart (Sheet F - Exercise Mode Problems)


CHECK THE FILTER IN THE FLOW SENSOR. ENSURE THAT IT IS NOT BLOCKED AND THAT IT IS CLEAN. REPLACE IF NECESSARY AS DETAILED ON PAGE 3.36.
CHECK ALL SPIROMETRY CABLING. ENSURE THAT ALL CONNECTIONS ARE SECURE.
FLOW SENSOR AND CABLE OK?
NO
REPLACE THE FLOW SENSOR.
YES
ENTER THE SPIROMETRY MENU (<SPIRO>. ENSURE THAT THE CALIBRATION IS CORRECT AND ALL SETTING ARE CORRECT.
CAN THE CALIBRATION PROCEDURE BE CARRIED OUT?
NO
CHECK FLOW SENSOR. CHANGE:
1. BUS INTERFACE BOARD
2. PROGRAM PACK
3. PROCESSOR BOARD
YES
POSSIBLE OPERATOR ERROR.

Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Fault Diagnosis Chart (Sheet G - Spirometry Problems)


PRESS <STORAGE> <1> (TRANSMISSION MODE SETTINGS). CHECK THAT ALL SETTINGS(PARITY, STOP BIT) AND THE BAUD RATE ARE THE SAME IN BOTH DEVICES.
PRESS <STORAGE> <2> (SELECT TYPE OF TRANSMISSION). CHECK THAT ALL SETTINGS(LINE OR MODEM, RECORD OR BLOCK) ARE CORRECT FOR THE APPLICATION.
ARE THE SETTINGS COMPATIBLE IN BOTH THE TRANSMITTING AND RECEIVING DEVICES?
NO
PROGRAM ALL SETTINGS TO ENSURE COMPATIBILITY BETWEEN THE COMMUNI-CATING DEVICES
YES
CARRY OUT THE RS SELF TEST PROCEDURE DETAILED ON PAGE 3.20.
TEST PASSED?
NO
1. CHECK THE +12V AND -12V SUPPLY VOLTAGES AS DETAILED IN PARAGRAPH 5.
2. CHANGE THE PROCESSOR BOARD
3. CHANGE THE RS CONNECTOR ASSEMBLY
YES
POSSIBLE OPERATOR ERROR.
CHECK ALL CABLE ASSEMBLIES. REPLACE IF NECESSARY

Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-60 Fault Diagnosis Chart (Sheet H - Communication (RS) Problems)

Check Procedures

General Confidence Check

The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test but is intended to identify any faults that may be present after the unit has been reassembled. To carry out the general confidence check of the AT-60 proceed as follows:

1. Ensure that the voltage selector on the back panel is set for the required voltage and connect mains to the unit. Switch on the mains and ensure that the green mains LED on the hinged LCD Assembly lights.

2. Switch the unit on by pressing the <ON> key on the Keyboard for approximately a second. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.

3. Press <FNCT> <2> <2> and enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen.

4. Using a small blunt instrument, press the red master reset button on the side panel.

5. Connect the ECG phantom to the ECG connector on the side panel and switch the phantom on. Ensure that a good ECG trace is displayed on the screen.

6. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality. Press <MAN START> and ensure that the print-out is accurate and of good quality.

7. Press the <AUTO START> key and wait approximately 10 seconds for the printout to commence. Ensure that the print-out is accurate and of good quality.

8. Press the <PATIENT DATA> key and systematically press the keys:

   <QWERTY UIOP>, <ENTER>, <1234567890>

   Ensure that the entered data is correctly presented on the screen as entered. Press <ESC> to exit the patient data display.

9. Press the <BEGIN> key and ensure that the AT-60 indicates that an exercise test has commenced. Press <END> and <PRINT REPORT> and ensure that a print-out is given. Press <STOP>.

10. Enter the required static parameter values. After resetting, store the entered parameter values by pressing <FNCT> <2> <5>.

    Note: A description of the programmable parameters, the parameter values and the procedure to set them, is provided in the AT-60 Operating Manual.

11. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out). Switch the unit off and leave connected to the mains supply for 24 hours to fully charge the battery.

Check Procedures (cont.)

Power Supply Confidence Check

1. Connect mains to the unit and switch on. Ensure that the mains LED lights.
2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads.
3. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality.

   Note: If the print-out quality is poor and the printer has not been changed, the stored printer resistance data may have been lost from memory. To check the stored resistance setting see paragraph `Self Test Screens and Offset Adjustments´. If problems are experienced with paper mark detection or setting the printer speed it may be necessary to adjust the factory pre-sets on the Keyboard I/F, TP Control, Audio Amp board (see Paragraph 5- Adjustments).

4. Press any key and ensure that the buzzer beeps.
5. Check the ±12V supplies by carrying out the RS test procedure detailed in Paragraph 4.4.
6. Disconnect the mains supply and ensure that the green mains LED is extinguished and that the yellow battery LED lights.

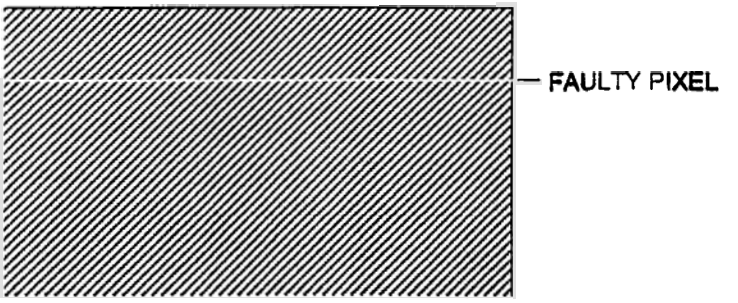
If all these checks are satisfactory it indicates that the Power Supply board is functioning. If any of the checks fail, the individual power supplies must be checked.

Printer check

To check the printer and to ensure that every pixel is operational, a built-in printer test is provided. To carry out the printer check enter the following key sequence:

<ECG> <7> (electrode test) <P>

A print-out of a series of diagonal lines will be given. Carefully examine the print-out and ensure that all the lines are even and uninterrupted. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print.



If a faulty pixel is detected the printer must be replaced. If the print-out is uneven (for example darker at the top than the bottom), it indicates that the printer alignment is not correct. If the print-out is too faint or too dark, check that the correct resistance is entered in memory as detailed on page 3.18.

Check Procedures (cont.)

Printer Resistance

Check that the correct resistance of the printer is entered in the AT-60 memory as follows:

Note: The printer resistance will be found on a label attached to the printer.

1. Enter the following key sequence <ECG> <7> ENTER> <ENTER>
2. R TPH is the resistance of the printer. To enter a new resistance value press </>. The first figure of the resistance value is highlighted and the correct resistance value can be entered. When the correct resistance value has been entered, press <ENTER> to save the setting. Note that the AT-60 will only accept a resistance range of between 1000 and 1600 Ohms.

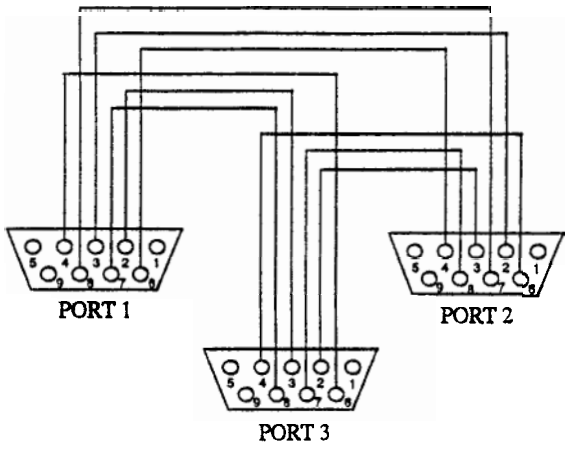
RS Interface Error messages

The following error messages are associated with the RS Interface. If any of these error messages are displayed, carry out the checks suggested.

SERIAL LINK TIME-OUT	This indication appears if no signal is received from the remote unit (after approximately 30 seconds). ◊ Check that the remote unit is switched on and set to the correct parameters ◊ Check the correct set-up in both units (<STORAGE> key) ◊ Check that the connecting cable is correctly plugged in ◊ Check the integrity of the cable assembly(s) (at both units) ◊ If using a modem ensure that it is communicating with the remote modem
TRANSMISSION ERROR	This is a general fault indication ◊ Check that the remote unit is switched on and set to the correct parameters ◊ Check that the connecting cable is correctly plugged in ◊ Check the integrity of the cable assembly(s) (at both units) ◊ If using a modem, ensure that it is communicating with the remote modem
NO ECG IN MEMORY	An ECG transmission has been attempted, but no ECG is stored in the units' memory. Store an ECG in the memory and attempt the transmission again. If the same message appears, change the Microprocessor Board.

RS Interface Testing

RS Interface Test Cable (Part No. 2.310 042)



RS 232 Pin Connections	
PIN	**SIGNAL**
3	Out (Data Output)
2	In (Input Data)
7	RTS1 (Output - Request to Send)
8	CTS1 (Input - Clear to Send)
6	DSR1 (Input - Receive Unit Ready)
4	DTR1 (Output - AT-60 Ready)
5	Ground

RS Interface Testing (cont.)

Test Failure

If this test fails ensure that the cable assembly is wired and connected correctly. If the test cable assembly is correct, a fault is indicated on the Processor Board or Power Supply.

Test Pass

When this test passes it indicates that the fault lies in the remote equipment, the transmission line or that the protocol of the two communicating devices are incompatible.

- Check that all settings (Parity, Stop bit) and the Baud rate are the same in both devices.
- Reset all settings to ensure compatibility between the communicating devices. Check that all settings (Line or Modem, Record or Block) are correct for the application. Are the settings compatible in both the transmitting and receiving devices?
- Check the integrity of all cable connections. Are all cables correctly connected to the programmed port?

Test Input / Output

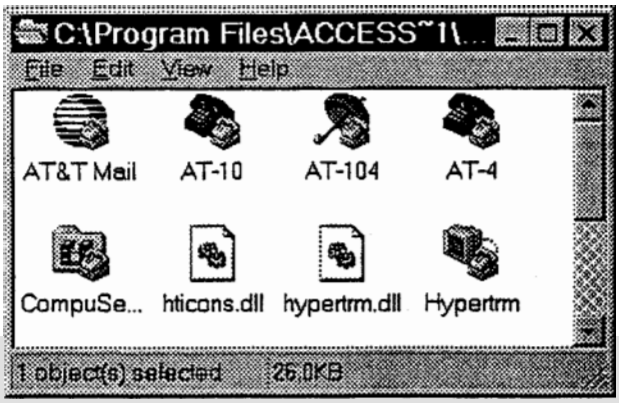
The test transmission / test reception options enables a test sequence to be generated and received. Use these test options to ensure that the receiving and transmitting units can communicate and that the cable assemblies, connectors etc. between the communicating units are good.

The test message generated is a string of all ASCII characters - ABCD.... 1234....abcd... etc. When the test transmission / reception option is selected, the string of characters sent by the transmitting unit are displayed on the LCD in the receiving unit. In the transmitting unit a message is displayed indicating that a test transmission is in progress.

To perform these tests, you will need a second AT-60 unit, or the AT-60 RS-232 (#3) interface has to be connected to an active terminal, for example the Hyperterminal, which is available under Windows 95™. The following equipment is needed:

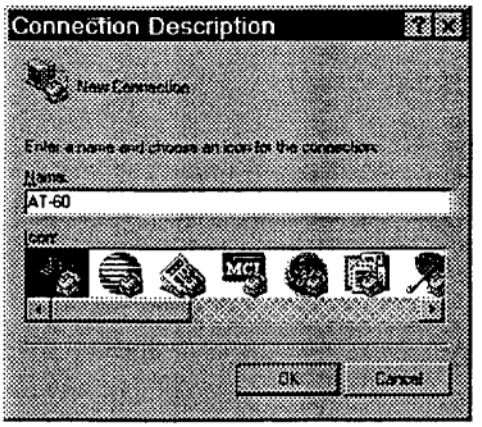
- A personal computer (PC) with Windows 95™ Hyperterminal installed.
- An RS-232 cable assembly, Art.No. 2.310 159, for connecting the RS-232 (#3) interface on the AT-60 with the COM port of the PC. This assembly consists of a cable, Art. No. 2. 310 094 and an adapter DB 9 / DB 25, Art. No. 2. 100 552.

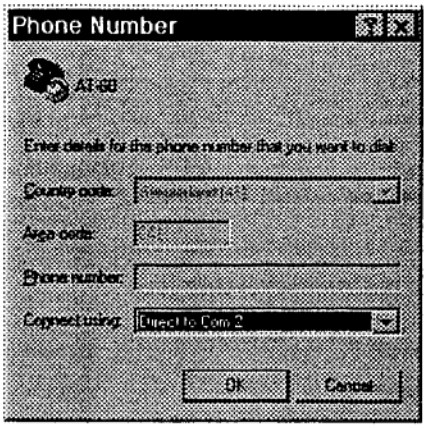
1. Start from Windows 95 desktop. Click on START. Select Programs / Accessories / Hyperterminal.



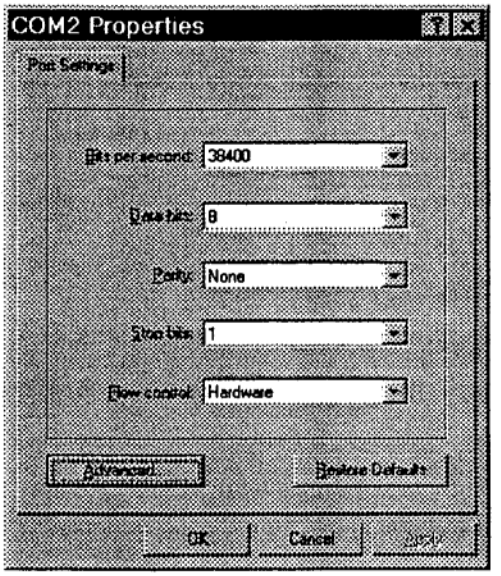
2. Double-click on Hypertrm(.exe). Enter the name AT-60 for the new connection and click on OK.

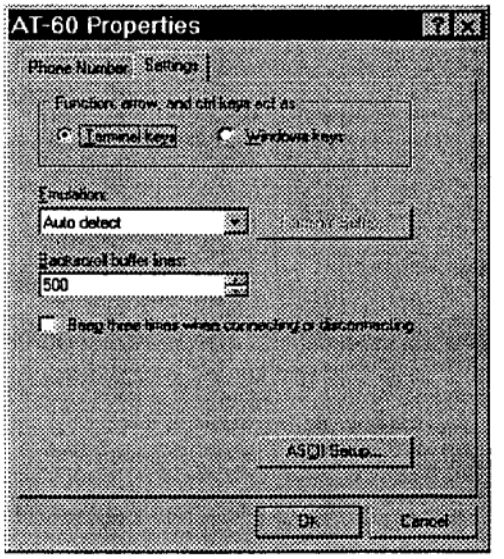
RS-232 Transmission/Reception Test (cont.)





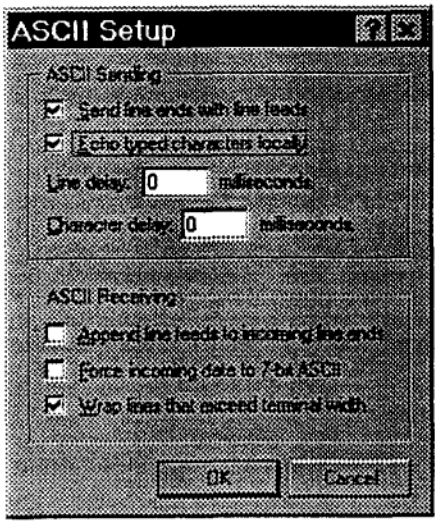
3. Set the direct connection to the proper COM-port and click OK.
4. Enter the port settings 19200, 8, N, 1, Hardware and confirm with OK..





5. You are now in the AT-60 Hyperterminal window. Click on File and select Properties.
6. Go to tab Settings and set Terminal keys, Auto detect and 500 buffer lines.
7. Click on ASCII Setup.

RS-232 Transmission/Reception Test (cont.)

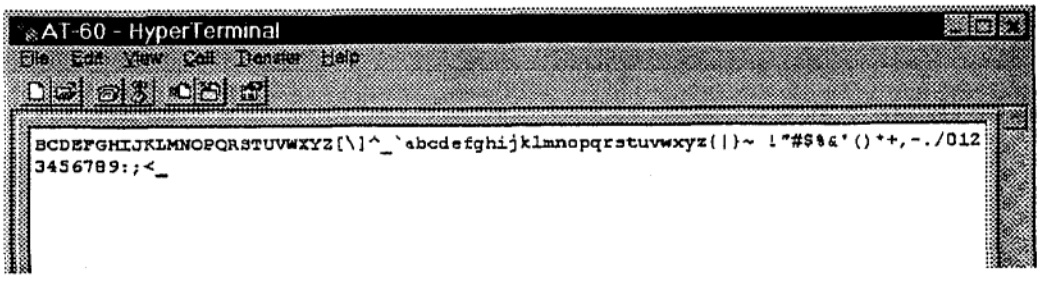


8. Check the boxes for "Send line ends with line feeds", "Echo typed characters locally" and "Wrap lines that exceed terminal width". Confirm with OK. Click once more on OK to get back to the open Hyperterminal window.

You are now ready to start the input and output tests.

Test Output

- On the AT-60, press the <STORAGE> key and select Test mode. Make sure that the settings are 19200 bps, parity N, stopbit 1. Set Channel No. 3.
- Press key <5> 'Test output on channel n' on the AT-60.
- The AT-60 now sends a string of alphanumerical characters, which are echoed in the Hyperterminal window on the PC.

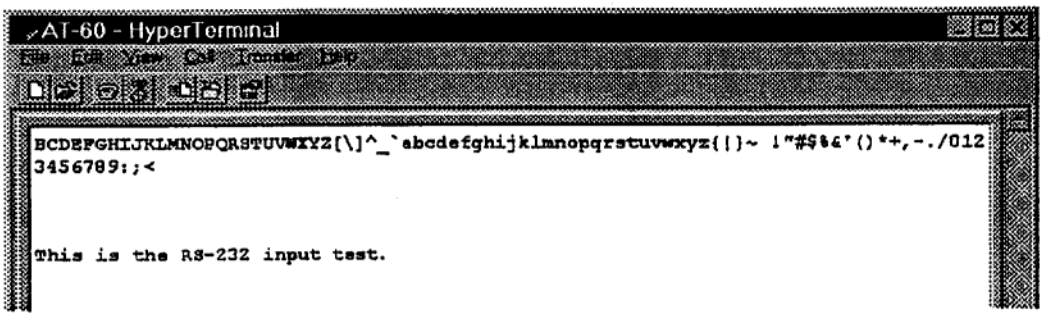


- Stop the test by pressing key <7> 'End of test input/output'.

RS-232 Transmission/Reception Test (cont.)

Test Input

- In the RS-232 test window, press the key <6> 'Test input on channel n'. The upper part of the RS-232 test window is erased to be able to display incoming messages.
- On the PC, type any characters and verify that they are echoed on the AT-60.

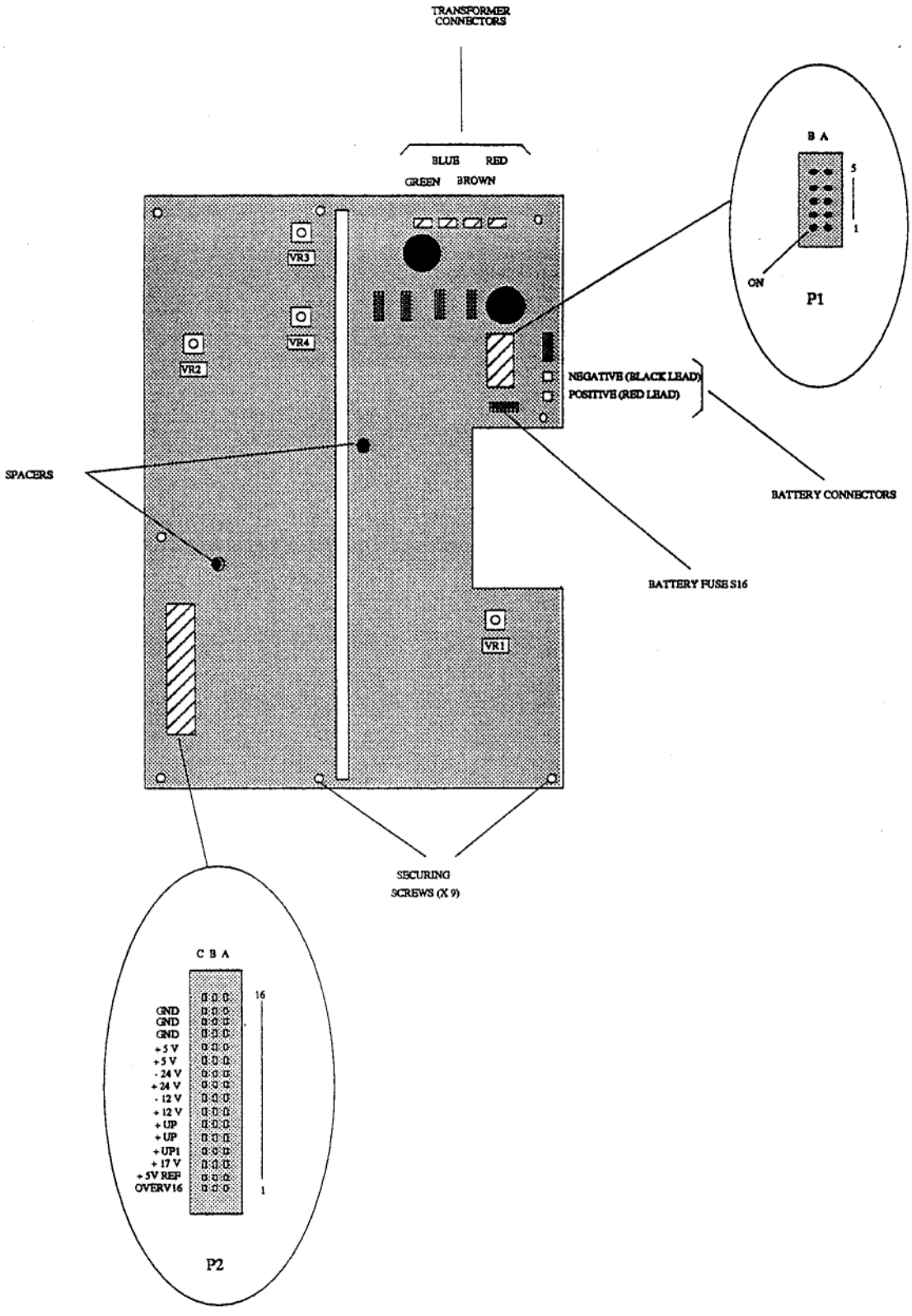


- Stop the test by pressing key <7>. Leave the RS-232 test window by pressing ESC.

Error Codes

The error codes shown at the bottom of the display have the following interpretations:

DSR	Data set ready
BD	Break detected
FE	Frame error
OE	Overrun error
PE	Parity error
TxE	Transmitter empty
RxR	Receiver ready
TxR	Transmitter ready


TRANSFORMER CONNECTORS
BLUE
RED
GREEN
BROWN
VR3
VR4
VR2
VR1
B A
5
1
ON
P1
NEGATIVE (BLACK LEAD)
POSITIVE (RED LEAD)
SPACERS
BATTERY CONNECTORS
BATTERY FUSE S16
SECURING SCREWS (X 9)
C B A
16
1
GND
GND
GND
+5 V
+5 V
-24 V
+24 V
-12 V
+12 V
+UP
+UP
+UP1
+17 V
+5V REF
OVERV16
P2

Adjustments

Power Rail Adjustment Procedure

The power supplies generated by the Power Supply board can be checked in isolation; it is not a requirement that the unit has to be assembled to check the power supplies. If the power supplies are checked when the Power Supply is connected to the Processor board however, a more accurate measurement may be achieved.

No test measuring points are present on the Power Supply board and measurements must be taken on the components themselves or on connectors. Most of the supplies appear on connector P2 and it is recommended that this connector is used for measurement. To take measurements on this connector, needle test leads are required. To provide more secure attachment of the test leads, it is recommended that an open-backed compatible plug is fabricated to facilitate the attachment of crocodile leads.

The 13.8V battery charge voltage is not present on the P2 connector and voltage measurement must be made from the battery fuse.

No adjustment is possible for the switching regulators (5V, ±12V, -24V).

The battery indicator off-set can only be adjusted when the unit is assembled.

WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THE POWER SUPPLY. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENTS.

On Signal Simulation

A latch circuit exists on the power supply to switch the Power Supply on and off. If the Power Supply board is checked in isolation an ON signal must be generated to simulate the on signal from the processor. The on signal is an active low. To simulate the on signal, proceed as follows:

1. Connect mains to the unit and switch the mains on.
2. Using a suitable lead, connect ground to Plug P1 pin 1B, and hold for 2 seconds. The Power supply will now be latched on and all generated power supplies can be checked for the correct voltage.

Note: To switch the power supply off, connect +5V to P1 pin 1B.

Printer Voltage (+24V) Adjustment

To check and adjust +24V supply proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at socket P2 pin 9. Adjust VR1 to achieve a voltage of +24V.

Adjustments (cont.)

Battery Charge Voltage (13.8V) Adjustment

This voltage can only be accurately adjusted when the battery is fully charged. To check and adjust the battery charge voltage proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at the battery fuse SI6. Adjust VR3 to achieve a voltage of +13.8 V.

Control Voltage (+17V) Adjustment

To check and adjust the +17 V supply proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at socket P2 pin 3A or pin 3C. Adjust VR4 to achieve a voltage of +17V.

   Note: When working from battery power this voltage is approximately 0.5V lower.

Battery Low Voltage Detection Adjustment

The low voltage detection circuit monitors the battery voltage and sets the battery low and the battery down signals. These signals are used to give a visual indication that the battery voltage is getting low (battery LED flashing) and to switch off the unit when the battery voltage is below a minimum level. The nominal battery voltage at which the Battery Low signal become active is 11.3V. The nominal voltage at which the Battery down signal becomes active is 9.2V.

Service Note: A delay circuit is provided on the Power Supply board to compensate for high power peaks eg printing, which could `trick' the battery voltage detection circuit into thinking that the battery power is low. It ensures that the when the unit is working from the battery, the battery LED does not flash or the unit switch off, when the printer is activated.

This compensation circuit is linked with the battery low voltage detection circuit. If the battery LED flashes, or the unit switches off when printing on battery power, it can indicate that this adjustment is incorrectly set.

To carry out this procedure the unit must be assembled (and the Processor board installed) with the Top Assembly placed by the side of the Base Assembly and all cable assemblies between the two assemblies, connected.

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To adjust the low voltage detection circuit proceed as follows:

1. Ensure that the mains supply is disconnected and remove the red and black battery leads from the Power Supply board. Connect a stabilised variable power supply to the two battery bayonet connectors (on the Power Supply board).

Adjustments (cont.)

2. Set the power supply to +12V and switch the AT-60 on. Ensure that the unit switches on and that the Battery LED, next to the LED, is lit.

3. Reduce the power supply to 11.35V and ensure that the LED indicator lights continuously. Reduce the power supply further to 11.25V. Ensure that the LED indicator is now flashing. Adjust VR2 as necessary.

4. Reduce the power supply to 9.2V and ensure that the Battery LED continues to flash. Slowly reduce the power to 9.15V. Ensure that the unit switches off and that the battery LED is extinguished by 9.15V. Adjust VR2 if necessary.

Note: Adjustment of VR2 affects both the battery low signal and the battery down signal and it may not be possible to have both these signals exactly within tolerance at the same time. When this is the case, set VR2 so that the battery low threshold is within tolerance. The battery low signal is a nominal value and not critical within 11V and 11.3V.

K/B I/F, TP Control and Audio Amp Board Adjustments

Three potentiometers are present on the Keyboard I/F, TP Control, Audio Amp Board MK 7-5 as follows:

Beeper Volume (VR3)	This pre-set adjusts the beeper volume. Use a small flat-bladed screwdriver to adjust the beeper to the volume required.
Paper Mark (VR2)	This pre-set is used to adjust the paper mark detection circuit threshold so that the paper mark is recognised. The paper mark is used for calculation of print-out commencement position, paper detection, paper present etc.
Motor Current Limiter (VR1)	This is a safety threshold to limit the maximum current to the printer motor.

To gain access and to set the three potentiometers, the Top Assembly must be removed and positioned adjacent to the Base Assembly; all interconnecting cables between the two Assemblies must be connected. See Chapter 5 for Removal and Replacement Instructions.

Note: It may be necessary to remove the Keyboard I/F, TP Control, and Audio Amp Board to adjust the potentiometers.

Paper Jammed Indication

When the detection circuit does not recognise the paper mark, a paper jam error message may be displayed. Before carrying the paper mark adjustment procedure, ensure that the paper detector window is clean.

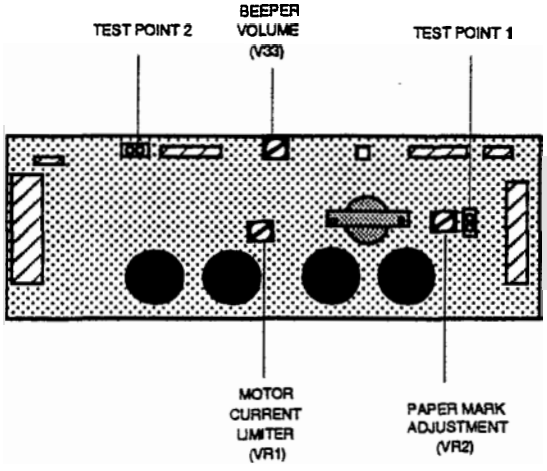
WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THIS BOARD. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENTS.

Adjustments (cont.)

CAUTION

TAKE CARE NOT TO PLACE ANY STRAIN ON ANY CABLE ASSEMBLIES AND CONNECTORS.



Keyboard I/F, TP Control and Audio Amplifier Adjustment Potentiometers

Paper Mark Adjustment

Set the paper mark threshold as follows:

1. Connect a digital voltmeter across the P12 connector (test point 1).
2. Switch the unit on and adjust VR2 to obtain a reading as follows:
   - > 3.5V when the black paper mark is under the paper mark detector
   - < 0.3V when there is no paper mark under the detector ie white paper

NB IF THE DETECTION DOES NOT RECOGNISE THE PAPER MARK AFTER ADJUSTMENT, ENSURE THAT THE PAPER MARK WINDOW IS CLEAN.

Motor Current Threshold

Set the motor current threshold as follows:

1. Connect a digital voltmeter across the P5 connector (test point 2).
2. Switch on the unit and set the printer to run at 25 mm/s. During the print run adjust VR1 so that the voltmeter reads 6 mV.

Self Test Screens and Offset Adjustment

There are three test screens built into the AT-60 for use by the service engineer. The first screen provides test information of the patient cable and electrode application. The second screen gives the value of certain reference voltages and important internal synchronisation measurements and the third screen gives variable settings and measurements. The first two screens are for information only, and no adjustment can be made to these values. Additional test equipment is required to carry out some of the settings on the third screen. The three test screens are as follows:

Electrode Test Screen	This screen indicates the electrode offset voltage and can indicate any faults in the patient cable or patient electrode.
Self Test Screen	This screen displays ECG internal reference voltages and internal measurements of synchronisation and other parameters.
Offset Settings Test Screen	This provides measurements and setting facilities for the analog offsets used for accurate control of exercise bikes and analog controlled treadmills. This screen also contains the thermal print head resistance setting option.

Electrode Test Screen

Use this screen to display the dc voltage between the left leg electrode and all other electrodes. The measurements obtained will indicate any cable short circuits or open circuits. To enter the electrode test screen proceed as follows:

1. Press <ECG> to display the main menu options.
2. Select option <7>, Electrode Test to enter the electrode test screen. The following display will be shown:

El	<mV>
RA	190
LA	190
C/V1	190
C/V2	190
C/V3	190
C/V4	190
C/V5	190
C/V6	190
C/V7	5
C/V8	5
C/V9	5

Self Test Screens and Offset Adjustment (cont.)

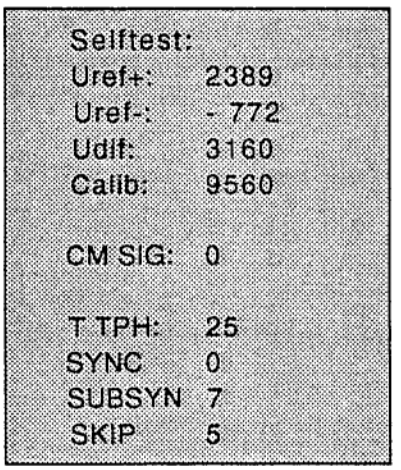
The measured voltage value will depend on where the electrodes are connected. The voltage readings that can be expected are as follows:

- With patient connected - ± 100mV
- With patient simulator connected - ± 10 mV - this will depend on the patient simulator used and must be taken as a flexible measurement.
- With all electrodes shorted together: - ± 20 mV

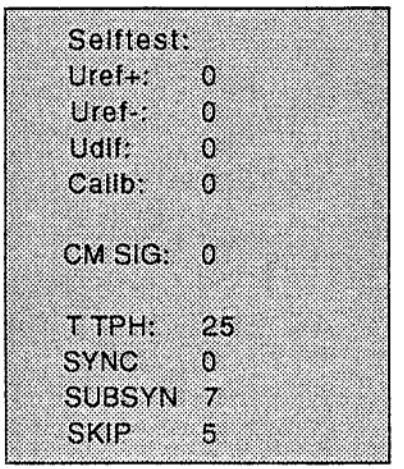
Self Test Screen

To enter the test screens proceed as follows:

1. When in the Electrode test screen, press <ENTER>. The following display will be shown:



MK 7-2 (ver. 0.4)



MK 7-20 (ver. 1.2)

NOTE: When the ECG board MK 7-20 is used, no values are displayed for Uref+ to CMSIG, they are all set to zero (0).

This screen gives the following data:

Uref +

This is the value of the reference voltage used in the multiplexer circuit on the ECG Amplifier. The value of the reference voltage is 2727 mV. However because the ECG amplifier has a floating ground, this figure is arbitary and the measured voltage can give a great varience to the true value.

Uref -

This is a negative reference voltage used on the ECG Amplifier board. Because the ECG amplifier has a floating ground this figure is arbitary.

Self Test Screens and Offset Adjustment (cont.)

Udif

This is the difference of the two reference values above (Uref + and Uref -).

Calib

This is the value of a signal generated by the CPU for calibration of the ECG signals. This value should be between 9500 and 10100 when no patient cable connected. With a 15 lead cable connected and all the leads shorted together this figure must read 10000 ±1%.

CMSIG

This measurement gives an indication of the common mode noise. A high reading indicates high common mode noise and thus the quality of the ECG reading may not be as good as with a lower noise level. The measurement indicates the amplitude of the output signal of the right leg driver circuit.

The patient must be connected to obtain a meaningful measurement. The range of the measurement is between 0 and 255. A high reading means that common mode noise is present and it may be necessary to move the unit to a less noisy environment. Sources of noise could include the following:

◊ bad electrode connection

◊ electric light

◊ electric motors, CRT monitors etc.

T TPH

This is the temperature of the print head heat sink. This measurement is used by the CPU to control the printer timing to obtain optimum print. The reading given here should be approximately the ambient temperature of the room. Note that if the printer has recently been active this reading may be higher than the room temperature.

SYNC

This value is a counter reading of the number of communication failures between the ECG Amplifier and the main CPU, since the unit was switched on. There should never be any communication failures and this value should be 0. If communication failures are occurring it indicates a problem with the ECG Amplifier board or the Processor board.

SUBSYNC

This counter gives the number of times that re-synchronisation of the data subvector has occurred. On initial switch on this counter could read 5 to 30. After initial synchronisation this figure should not increase. If re-synchronisation is occurring, check the optical link between the Processor board and the ECG Amplifier board.

SKIP

This counter gives the number of times re-synchronisation is necessary by skipping one ECG sample. On initial switch on this counter could read 5 to 10. Synchronisation is periodically required and over a 24 hour period the counter could be up to 100.

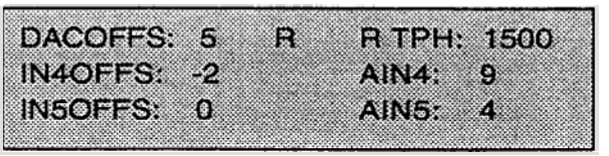
Self Test Screens and Offset Adjustment (cont.)

Offset Screen

This screen gives the value (and setting facility) for the thermal print head resistance and the value and setting option of various analog offsets for analog controlled stress test devices. A DVM is required to carry out the analog offset settings.

To enter the offset test screen proceed as follows:

From the self test screen press <ENTER>. The following display is shown:



This screen gives the following data and adjustments:

R TPH

The value indicated here is the resistance of the thermal print head and must be set to the correct resistance to ensure a good quality print-out. The print head resistance is found on the printer and can be accessed by removing the printer cover plate. The resistance is usually between 1050 Ohms and 1550 Ohms.

To set the resistance of the thermal print head press </>. The first figure of the resistance value is now highlighted and the new resistance value can be entered. The entered value must be more that 1000 Ohms and less than 1600 Ohms. If a resistance value outside of these limits is entered, the user is prompted to enter the value again. When the resistance is set press <ENTER>.

DACOFFS

This is an indication of the offset value of the digital to analog converter used for load or speed conversion for bicycle ergometers and analog treadmills respectively. To set this value proceed as follows:

1. From monitor mode enter the exercise menu and select the bicycle option as follows:

   <EXERCISE> <3> (Exercise Settings) <4> (Treadmill / Bicycle select) <1>
   as many timmmes as needed to achieve (Bicycle 1V/100W)

   Press <2> and Exit the exercise menu.

2. Commence an exercise test by pressing <BEGIN>. Press the <PROTOCOL> key and manually set the Base load to 100 W.

3. Wait 30 seconds and press <NEXT STAGE>.

4. Measure the voltage at pin 5 of the Stress. Using the <YES> and <NO> keys, set the DACOFFS value to obtain a reading of 1.00V ±5mV.

Self Test Screens and Offset Adjustment (cont.)

IN4OFFS and AIN4

This offset ensures that the correct value is interpreted on the load input value to the AT-60 from a bicycle. The IN4OFFS gives the value (-32 to 31) of the offset and the AIN4 gives the actual value. To set this offset proceed as follows:

1. Connect a power supply, with an accuracy of at least 0.1%, to pin 4 of the stress connector. Set the power supply to 1.0V
2. Adjust IN4OFFS using the left and right cursor, until a reading of 1000 (mV) ±5 is obtained at AIN4.

IN50FFS and AIN5

This offset ensures the correct reading for analog input of RPM (bicycle) or elevation (analog treadmill). The procedure to adjust this offset is the same as for IN4OOFS but the PSU must be connected to pin 1 of the stress connector and the <UP> and <DOWN> keys are used for adjusting the value.

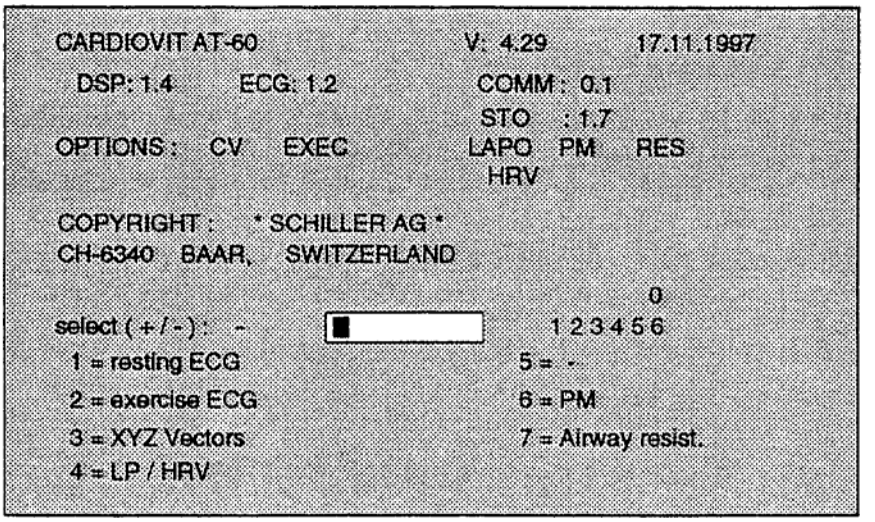
Software and Installed Options

To check the software version of the unit and to display all the systems options that have been installed, proceed as follows:

Display the software option screen by pressing the key sequence:

<ECG> <7> (Electrode test) <.>

The software version and the installed options are displayed on the LCD as follows:



- The top line gives the equipment name and the overall system software version of the unit; that is the software version of the EPROMs in the Program Pack. Full details of all the software versions are given in the AT-60 Operating Handbook.

Software and Installed Options (cont.)

- The second and third line give the software version of all the software controlled peripherals in the AT-60. These are as follows:
  - ◊ DSP - the software version of the digital signal processor on the Program Pack.
  - ◊ EKG - the software version of the single chip processor on the ECG Amplifier Board
  - ◊ COMM - the software version of the communications controller on the Processor Board
  - ◊ STO - the software version of the optional disk controller
- Below the software version details is the options line. This details the options that are installed. These are as follows:
  - ◊ CV - (C) Interpretation Program, (V) xyz Vectors
  - ◊ EXEC - analysis program for exercise ECGs
  - ◊ LAPO/HRV - Late Potential, Heart rate variability
  - ◊ PM - Pacemaker
  - ◊ RES - Airway resist. , Lung function test
- The number below, and to the right of the Copyright notice, is a counter of the number of unauthorized attempts that have been made to incorporate extra options to the unit.

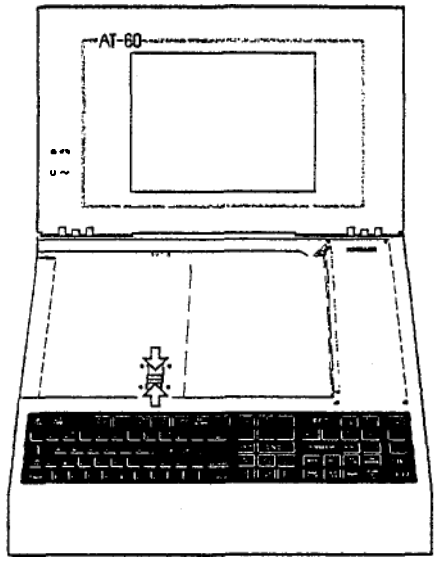
  Important - only 9 attempts are allowed and if this figure exceeds 9, no more upgrades are possible.
- The number immediately below the unauthorized attempts counter is the system serial number.
- The options on the bottom of the screen are the software updates that can be incorporated into the unit when the correct code is entered. To incorporate any of these software options the code must be entered, the option selected with the <+> and <-> keys and the <ENTER> key pressed. The code can be purchased from Schiller AG through your local dealer.

General Adjustments and Maintenance

Replacing the Recording Paper

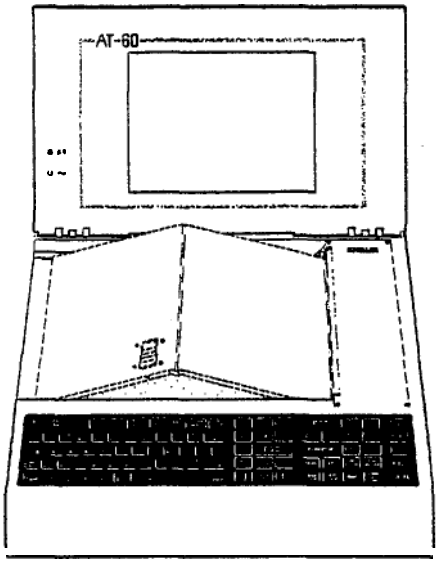
A red strip on the bottom edge of the recording paper indicates that it needs to be replaced. When this strip appears, there are about four pages left (ie approximately 120cm). We recommend that the paper be replaced as soon as this indication appears. Should the paper run out completely, then an audible alarm is initiated and the message "REFILL PAPER ! " appears on the display. To replace the paper, proceed as follows:

1. With thumb and forefinger, press together the two plastic slides on the paper tray release as indicated by the two arrows. The paper tray now lifts automatically in the middle.

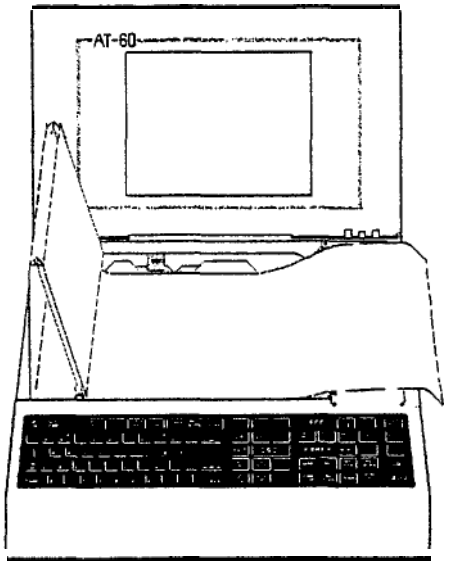


2. Place a finger under the raised part of the tray and pull it upwards and to the left until the **left-hand part is upright.**
3. Remove any remaining paper from the paper compartment.
4. Take a new pack of recording paper and place it into the paper compartment with the grid side downwards and with the black markings at the top of the paper towards the back of the unit.

General Adjustments and Maintenance (cont.)



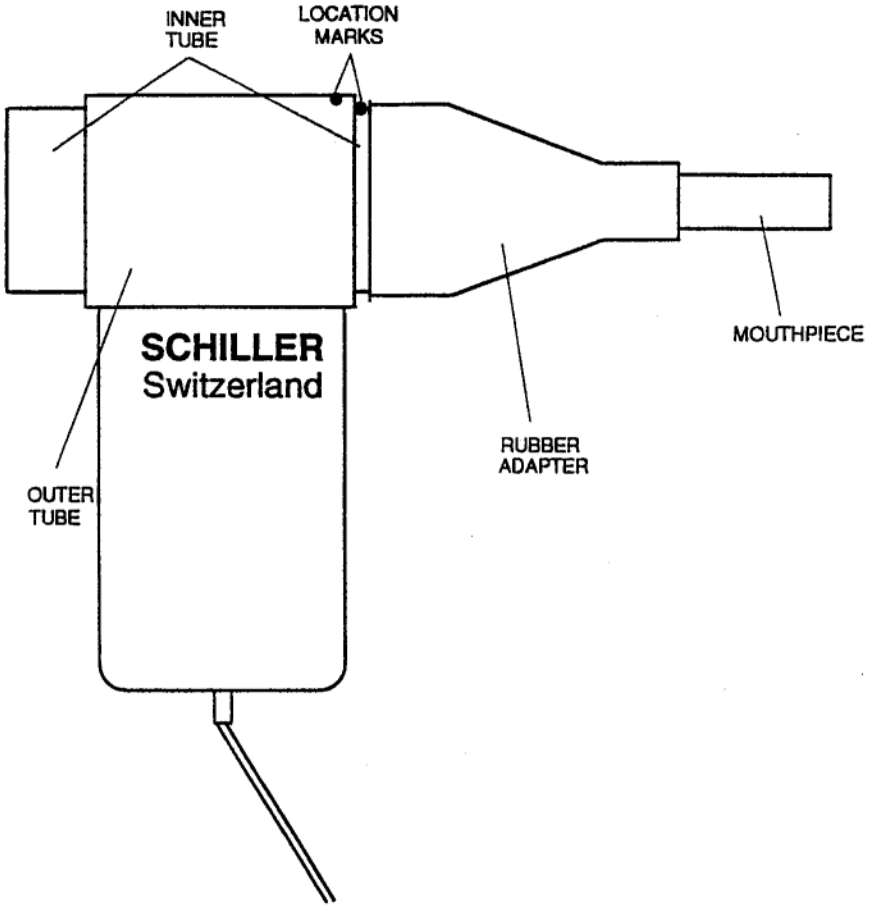
5. Pull the first two sheets of paper up and over the right-hand side of the unit.
6. Check that the paper is correctly aligned and then push the paper tray down into the horizontal position and press lightly in the centre until it clicks into place.
7. Place the first two sheets back over the top of the paper tray.
8. Press the **STOP** button, and the paper is transported to the correct starting position.



When printing is restarted, the warning message will be removed from the display.

General Adjustments and Maintenance (cont.)

Replacing the Flow Sensor Filter (Spirometer SP-100)



The filter is the only serviceable item on the flow meter. To replace the filter proceed as follows:

1. Remove and discard the mouthpiece.
2. Remove the rubber adapter by pulling it away from the inner tube.
3. Remove the inner tube of the flow sensor by pushing it out of the outer tube in the direction of the red location marks. Once the tube has been pushed half way it can be pulled out from the other side.
4. Unscrew the two halves of the inner tube and remove and discard the filter.
5. Clean and sterilize all parts of the inner tube, the rubber adapter and the inside of the outer tube with one of the following products:
   - ◊ Incidin GG
   - ◊ Amocid
   - ◊ Lysoformin
   - ◊ Alhydex

General Adjustments and Maintenance (cont.)

6. The cable and handle can be wiped with soapy water (do not dip into liquid!).
7. Insert a new filter into the inner tube so that it sits on the inner lip of the half with the red location mark.
8. Carefully screw the two halves of the inner tube together making sure that the filter is not displaced.
9. Locate the end of the inner tube into the end of the outer tube and push it gently but firmly until the shoulder of the inner tube makes contact on the outside edge of the outer tube. The two red location marks must be in line.
10. Fit the rubber adapter by placing its wider end over the end of the inner tube with the red location mark.
11. Insert a new mouthpiece (max. 1.5cm) into the end of the rubber adapter.

Chapter 4
Physical Overview & Module Replacement

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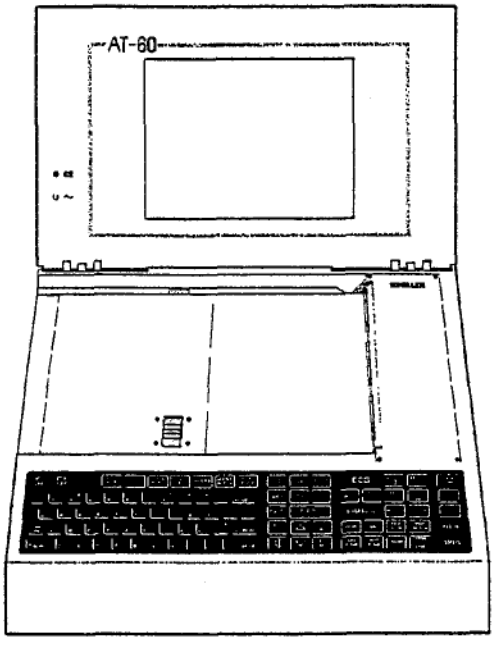
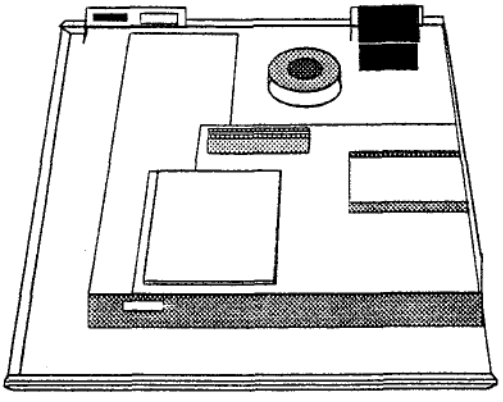


TOP ASSEMBLY



BASE ASSEMBLY

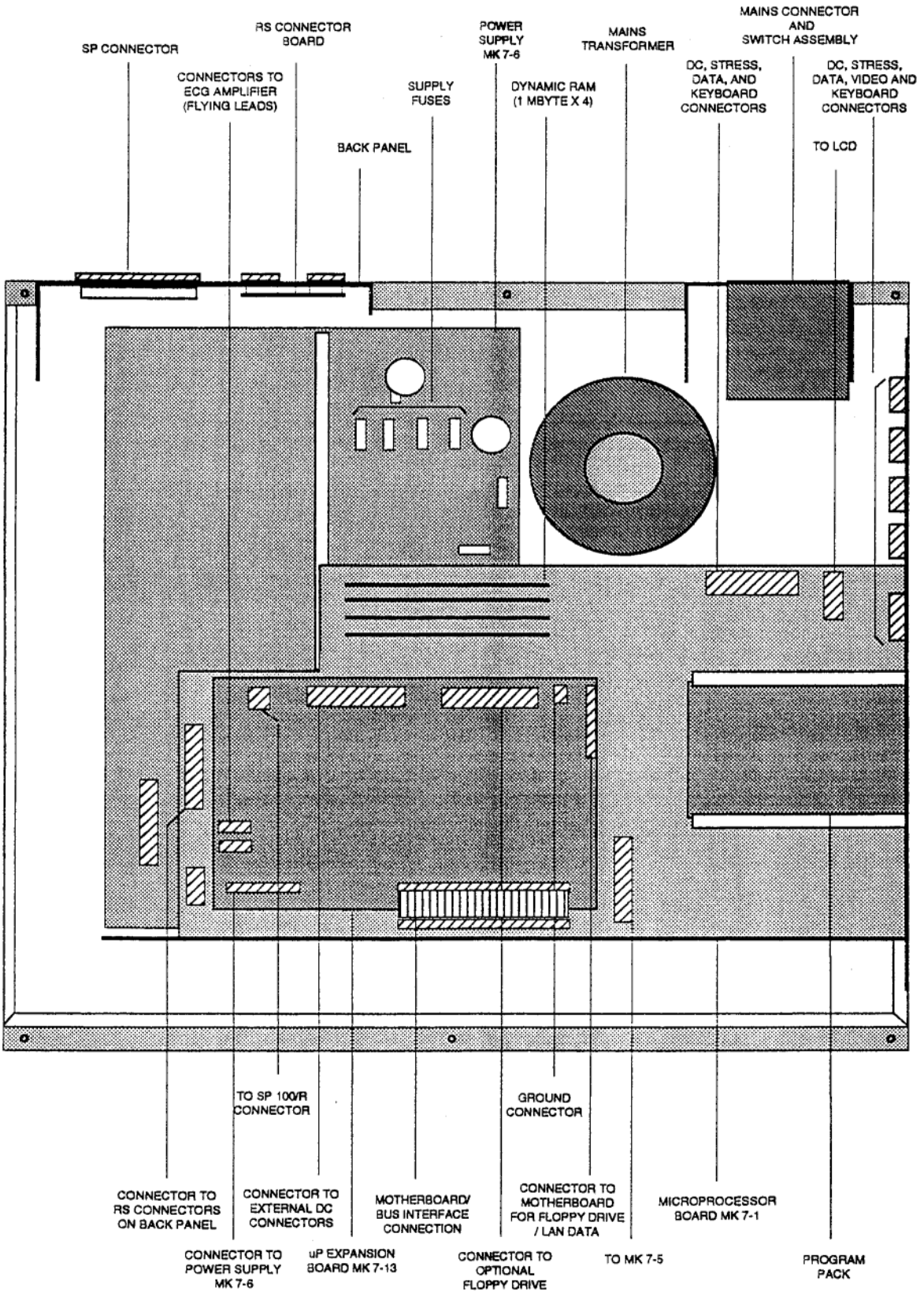
AT-60 Base and Top Assemblies

Introduction

The AT-60 comprises two main assemblies as follows:

- The Base Assembly
- The Top Assembly

The Base Assembly contains the battery, most of the electronics, and all of the AT-60 external connectors. The Top Assembly contains the operator controls and indicators and houses the keyboard, the printer and the LCD display. The two assemblies are moulded to fit together and are secured with captive screws. Electrical connection between the two assemblies is achieved with flying cables and ribbon cables.


SP CONNECTOR
RS CONNECTOR BOARD
CONNECTORS TO ECG AMPLIFIER (FLYING LEADS)
BACK PANEL
SUPPLY FUSES
POWER SUPPLY MK 7-6
DYNAMIC RAM (1 MBYTE X 4)
MAINS TRANSFORMER
MAINS CONNECTOR AND SWITCH ASSEMBLY
DC, STRESS, DATA, AND KEYBOARD CONNECTORS
DC, STRESS, DATA, VIDEO AND KEYBOARD CONNECTORS
TO LCD
TO SP 100/R CONNECTOR
GROUND CONNECTOR
CONNECTOR TO RS CONNECTORS ON BACK PANEL
CONNECTOR TO EXTERNAL DC CONNECTORS
MOTHERBOARD/ BUS INTERFACE CONNECTION
CONNECTOR TO MOTHERBOARD FOR FLOPPY DRIVE / LAN DATA
MICROPROCESSOR BOARD MK 7-1
CONNECTOR TO POWER SUPPLY MK 7-6
uP EXPANSION BOARD MK 7-13
CONNECTOR TO OPTIONAL FLOPPY DRIVE
TO MK 7-5
PROGRAM PACK

Base Assembly - Top Assembly Removed

Base Assembly

The base assembly comprises a galvanised, pressed steel tray onto which is mounted the mains isolation transformer, all external connector securing panels, and the PCBs containing the AT-60 electronics. A battery recess is positioned in the centre of the tray and a mounting panel, riveted on the base of the tray, provides support and securing points for the Processor Board. Access to the battery is gained from the bottom of the tray.

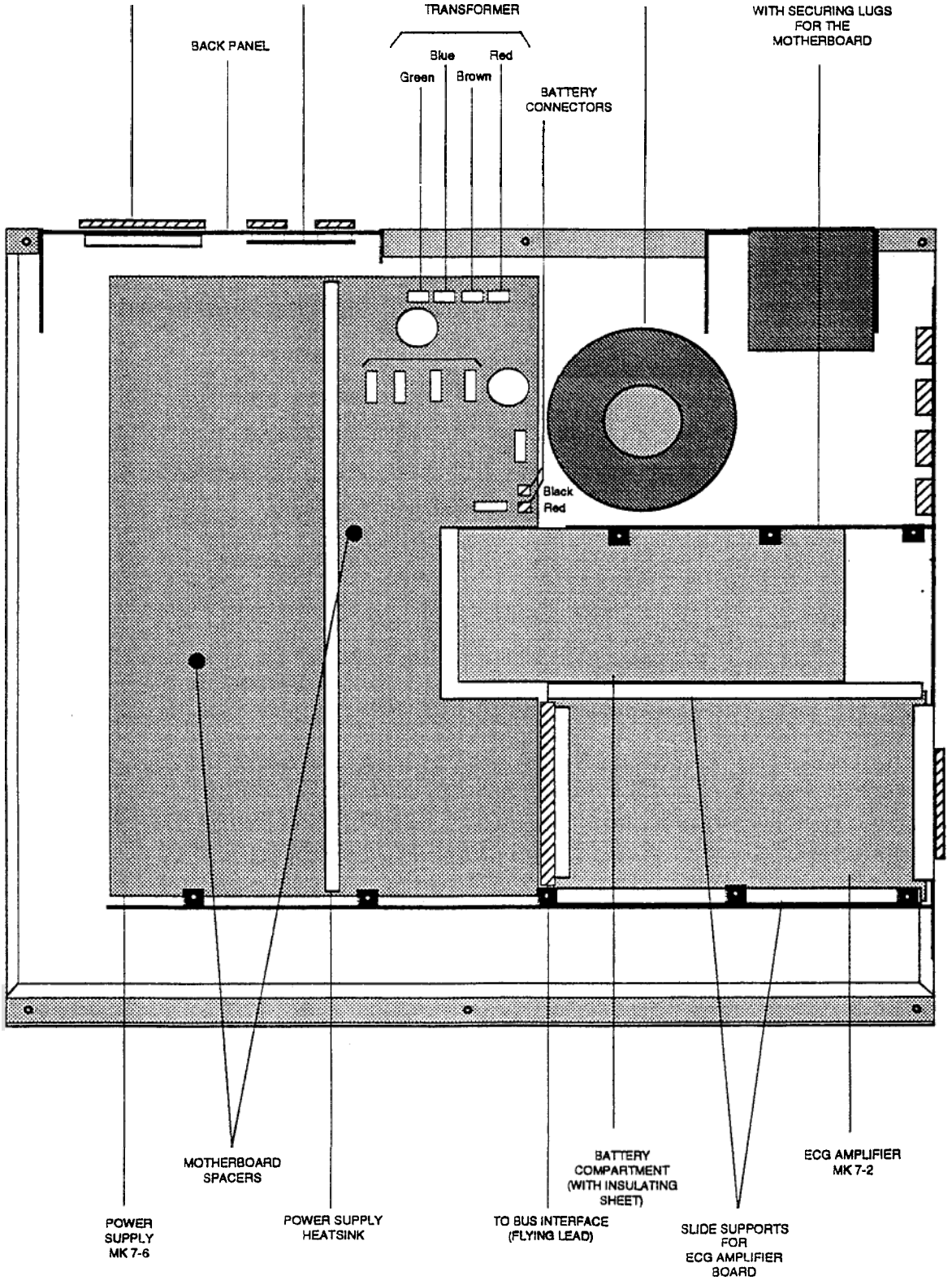
A side panel and a back panel provide mounting support for the external connectors. The connectors are secured to aluminium panels screwed to the side or back panel. Two external connectors are not mounted this way - the video connector which is mounted directly on the Processor Board MK 7-1, and the ECG patient cable connector, which is mounted directly on the ECG Amplifier Board MK 7-5. The two connecter panels contain cut-outs for the following:

Side Panel	• DC connectors
	• Stress, Data I/O and Keyboard Connectors
	• Video Connector
	• Program Pack
	• ECG Connector
Back Panel	• SP-100 connector (Spirometry)
	• three RS-232 connectors
	• RS-422 connector.

The Mains Connector and Switch assembly is secured to the Back Panel with spring loaded clips. The Mains Transformer is secured to the tray with a centre screw. The Power Supply board MK 7-6 is mounted and secured to seven spacers which are riveted to the tray base. Electrical connection between the Power Supply board, the Transformer, the Battery, and the Mains Connector and Switch assembly, is achieved by flying leads.

The Processor Board MK 7-1 is secured to the Mounting Panel and supported by spacers positioned on the Power Supply board. Mounted on the Processor Board are the following:

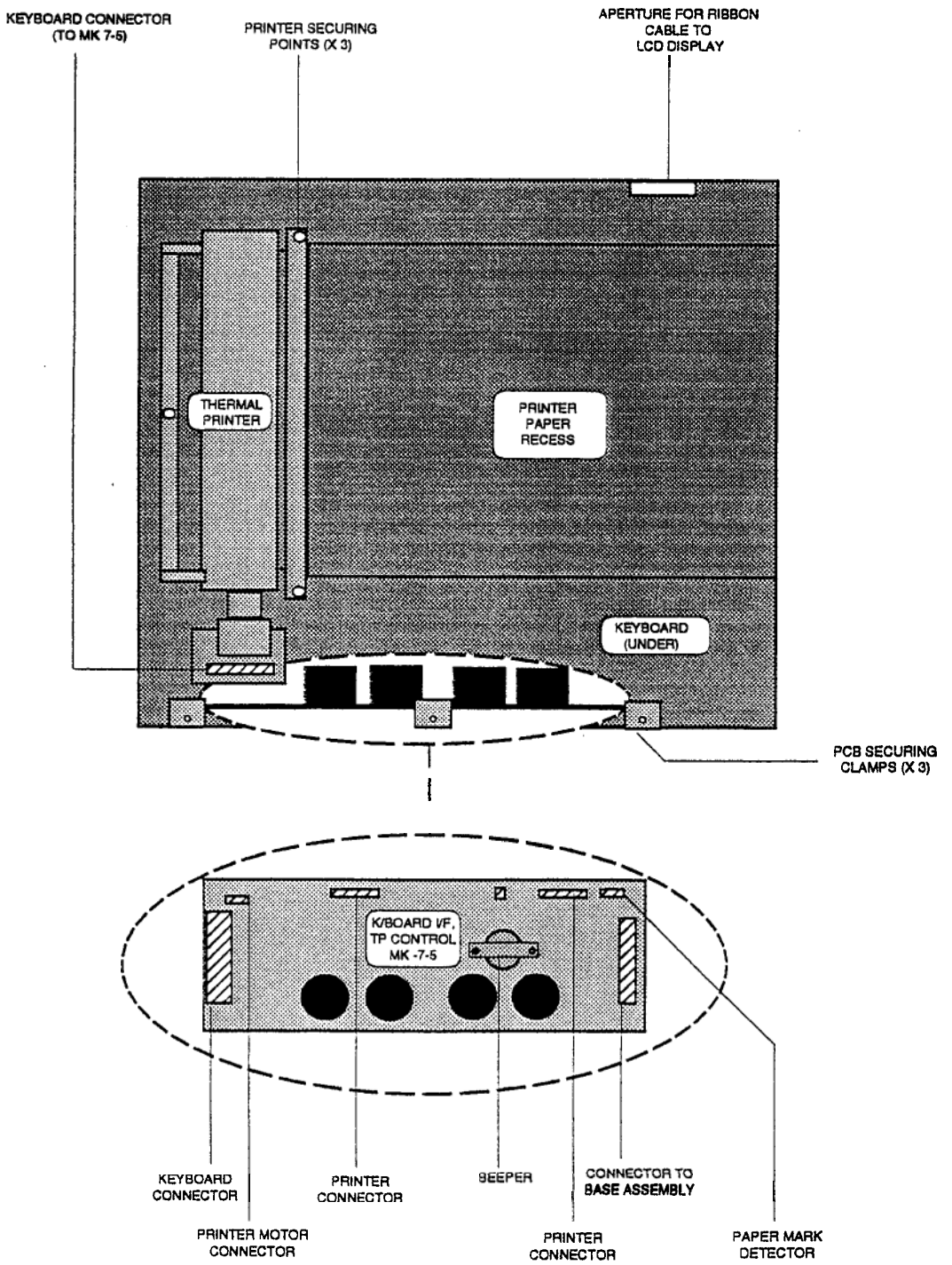
Bus Interface board MK 7-12	The Bus Interface board is separated from the Processor Board by six spacers and screws. The Bus Interface board connects electrically with the Processor board with a 64 wire ribbon cable and with all other boards via ribbon cable or flying leads.
Dynamic RAM	Four dynamic RAM modules connect directly to the Processor Board.
Program Pack	The Program Pack is inserted via a cut-out in the side panel. It is mounted in slides and connects directly with the Processor Board. Two captive screws secure the Program Pack in position.



Base Assembly - Processor Board Removed

Base Assembly (cont.)

The ECG Amplifier Module MK 7-2 is positioned under the Processor Board and is inserted into plastic slides via a cut-out in the side panel. The plastic slides are mounted on the base tray and are secured from the bottom of the tray with M4 screws. The board connects directly with a 64-way connector secured to the slides. A flying lead electrically connects the connector (and ECG module) to the Bus Interface MK 7-12.



Top Assembly - Main Housing (Viewed from Bottom)

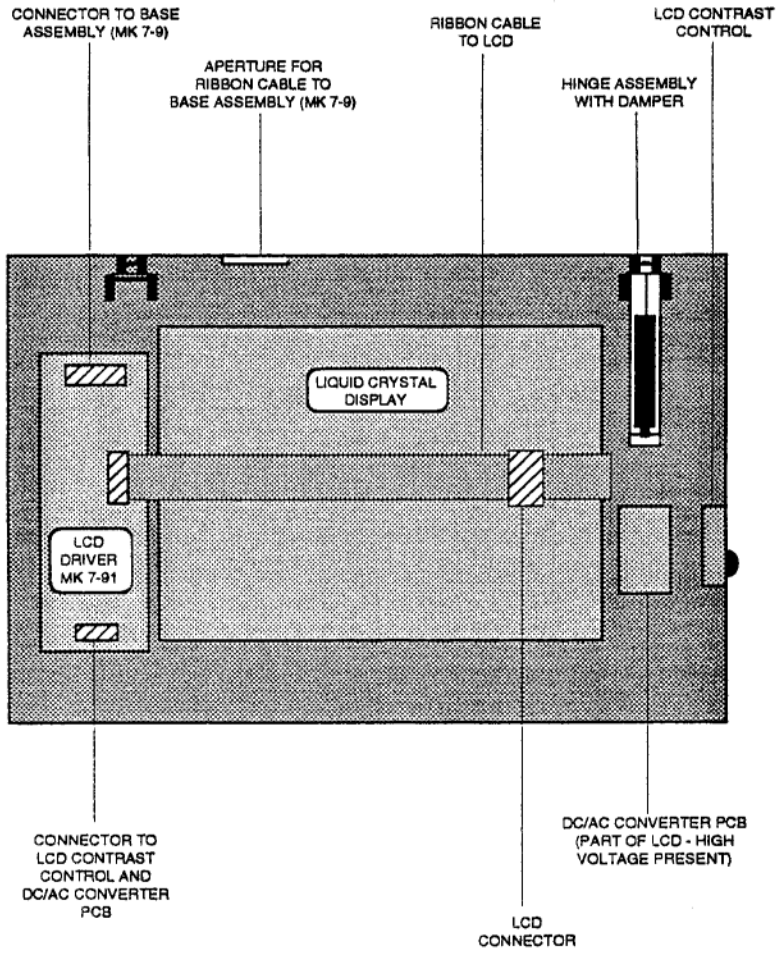
Top Assembly

The Top Assembly is manufactured by an injected plastic moulding process and comprises a Main Housing and a hinged LCD Housing. The right hand hinge has a hydraulic damping and mechanical locking mechanism to hold the LCD Housing in a selected position when the unit is in operation. Because of the plastic construction of the Top Assembly, threaded metal inserts are used for all screw fixings throughout this assembly.

Main Housing

The Main Housing contains the Thermal Printer, the printer paper recess, the Keyboard and the Keyboard Interface and Thermal Printer Control Board MK 7-5. The Thermal Printer is held in position with three captive screws, and the Keyboard and Printer Control Board is secured in slots moulded into the main housing and secured with three plastic clamps. Electrical connection within the housing, and to the Base Assembly, is by flying leads and ribbon cable.

The Keyboard comprises a keypad switch board with an annotated keypad cover. The switch board is secured in position with double sided tape. The Keyboard is electrically connected to the Keyboard Interface and Printer Control board via a ribbon cable


CONNECTOR TO BASE ASSEMBLY (MK 7-9)
APERTURE FOR RIBBON CABLE TO BASE ASSEMBLY (MK 7-9)
RIBBON CABLE TO LCD
LCD CONTRAST CONTROL
HINGE ASSEMBLY WITH DAMPER
LIQUID CRYSTAL DISPLAY
LCD DRIVER MK 7-91
CONNECTOR TO LCD CONTRAST CONTROL AND DC/AC CONVERTER PCB
DC/AC CONVERTER PCB (PART OF LCD - HIGH VOLTAGE PRESENT)
LCD CONNECTOR

Top Assembly - LCD Housing with Cover Removed

Top Assembly

LCD Housing

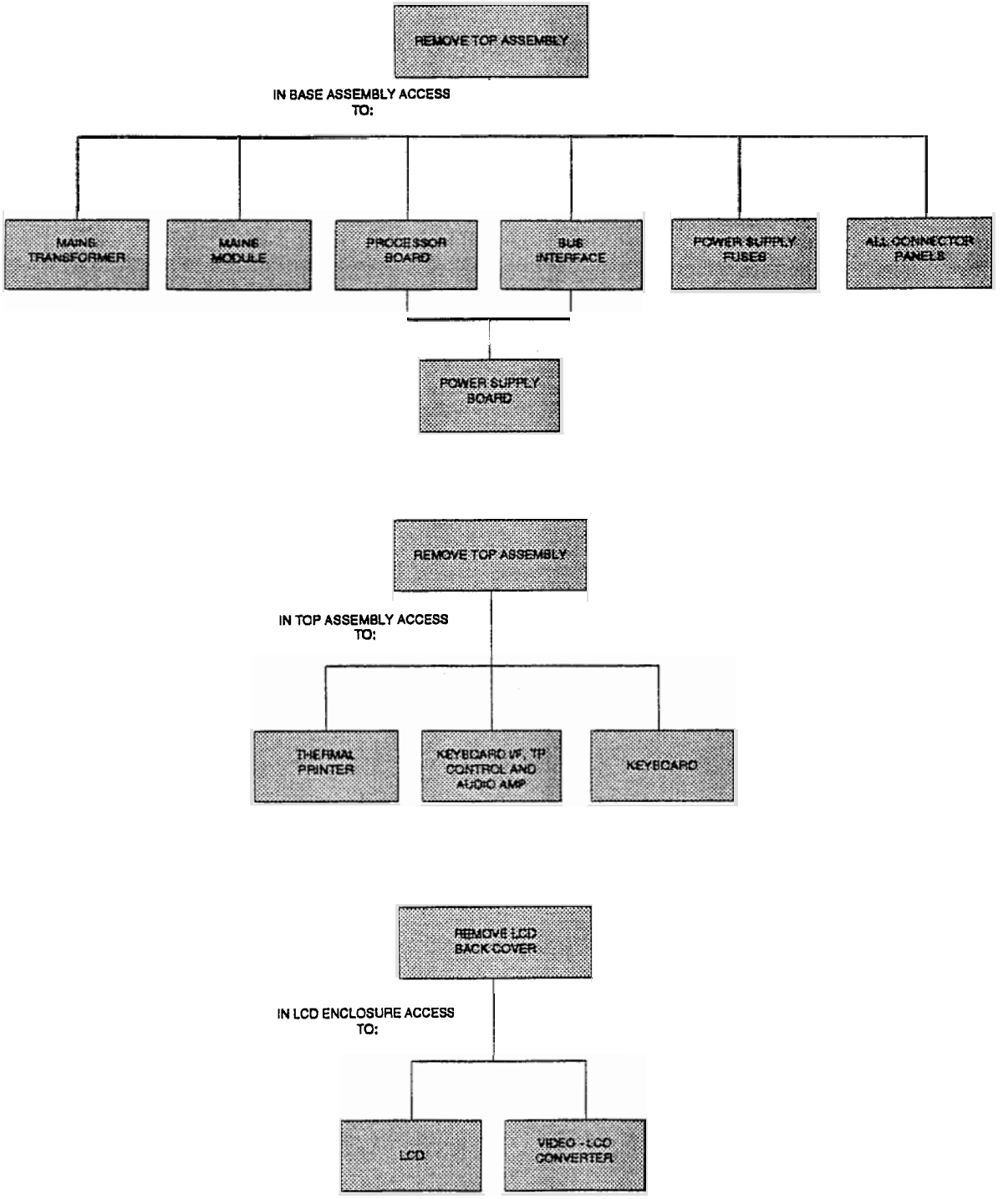
The LCD and Indicator section contains the following modules:

- LCD screen and DC/AC Converter board
- Video/LCD Converter board MK 7-91
- Beeper and Beeper Amplifier circuit.
- LCD Contrast Control

Access to the modules in the LCD Housing is gained by removing the top cover which is held to the LCD Housing with six screws. All the modules are secured to the interior of the housing with screws onto moulded mountings. Electrical connection with the main section is via a 16-way ribbon cable threaded through a cut-out at the rear of the assembly.

WARNING

THE LCD DC/AC CONVERTER BOARD GENERATES HIGH VOLTAGE. DISCONNECT THE MAINS BEFORE REMOVING THE COVER.



Note: Access to the ECG Amplifier Board and the Program Pack is gained via the Side Panel .
Access to the Lead Acid Battery is from the bottom of the unit.
Access to the mains fuse and the voltage selector is from the back panel (Mains Module).

Module Replacement

Introduction

This Chapter provides the procedures required to carry out the removal and replacement of all modules that are spared at service level. The instructions given in this chapter are autonomous, with each module containing the following:

- Removal Procedures
- Replacement Procedures
- Checks and Tests that must be carried to ensure the correct functioning of the module after replacement.

Each instruction specifies all the tools that are required and all the test equipment necessary to carry out the post replacement checks and functional test procedures. Also specified, are the pre-requisites that must be met before commencing a procedure. Any adjustments, jumper settings, special checks or functional procedures that are required during a procedure, are detailed in the relevant step.

In-text diagrams support the text where required and provide location details of connectors, test points and adjustment potentiometers.

Specific warnings and cautions are given in the text where applicable.

When a key operation or menu selection is required when carrying out the functional checks after replacement, the key sequence required is given in parenthesis `<>´. The character(s) given in parenthesis is the actual character(s) printed on the key. When a key sequence is provided it must be followed in the order given. For example the key sequence to display the macro screen is as follows:

<FNCT> <2> <ENTER>

This requires that the function key on the keypad is pressed, followed by the 2 key, followed by the return key (Enter).

Safety Notices

WARNINGS

MAINS POWER IS PRESENT WHEN THE UNIT COVER IS REMOVED. BEFORE COMMENCING ANY REMOVAL OR REPLACEMENT PROCEDURES ENSURE THAT THE MAINS POWER SUPPLY IS SWITCHED OFF AND THAT THE MAINS CABLE IS REMOVED.

CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED WITH MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

THE AT-60 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS.

◊ WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT.

◊ PERSONAL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS

◊ ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

THE PROCEDURAL STEPS GIVEN FOR EACH MODULE MUST BE FOLLOWED IN THE ORDER GIVEN.

Rechargeable Battery

Pre-requisites

The following tools and parts are required to remove and replace the rechargeable battery:

Tools

- Cross-Bladed screwdriver

Parts

- Lead Acid Battery. Suitable batteries are as follows:
  - YUASA NP 1.9-1212V/19Ah
  - VARTA 12V / 2Ah
  - Sonnensschein DRYFIT A212/A312 / 1.8S
  - Panasonic LCR-12V 1.9P

Battery Removal

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To remove the battery proceed as follows:

1. Ensure that the unit is switched off and that the mains is disconnected. Remove all cable assemblies connected to the front and rear panels.
2. Taking care to secure the hinged LCD module so that it cannot open, turn the unit up-side-down.

CAUTION

THE TOP ASSEMBLY IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING THE TOP ASSEMBLY PLACE THE UNIT ON A NON-ABRASIVE CLOTH WHEN UP-SIDE-DOWN.

3. Unscrew the nameplate and using the battery strap gently pull the battery away from the unit.
4. Disconnect the battery connectors.

Rechargeable Battery (cont.)

Battery Replacement

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To replace the battery proceed as follows:

1. Connect the battery connectors as follows:
   - Red lead to the + battery terminal
   - Black lead to the - battery terminal
2. Ensure that the battery removal strap is in battery compartment and place battery in position. Position the black lead in the groove at the top of the battery component.
3. Replace the Nameplate and return the unit to the upright position.

Checks and Tests After Battery Replacement

To ensure that the battery and battery recharging circuit are functioning after battery replacement, proceed as follows:

1. Connect mains to the unit and ensure that the green mains indicator next to the display is lit. Charge the battery for 24 hours.
2. Switch the unit on and program all static settings which will have been lost when the battery was disconnected.

Top Assembly

Pre-requisites

- The unit must be placed on an anti-static mat and anti-static precautions observed when any maintenance is carried out on the AT-60. The room temperature should be between 18 and 28 degrees.
- Mains supply is required to carry out the unit functional test after assembly.

Tools

A cross-bladed screwdriver is required to facilitate the removal and replacement of the Top Assembly with the Base Assembly.

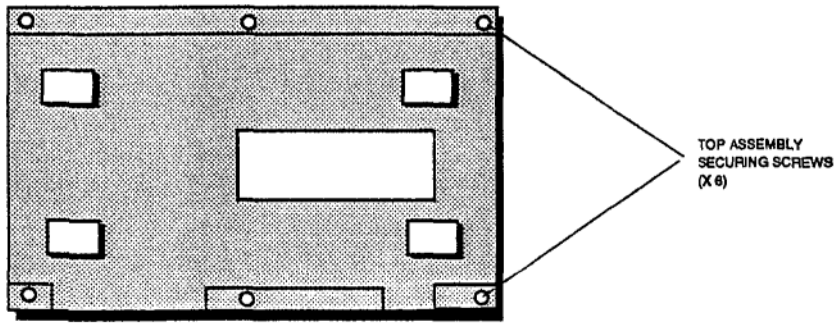
Test Equipment

The following test equipment is required to carry out the functional test after unit assembly

- Schiller Patient Cable
- Patient Simulator eg phantom 320.
- RS Test Cable (supplied by Schiller)

WARNING

MAINS POWER IS PRESENT WHEN THE UNIT COVER IS REMOVED. BEFORE REMOVING THE TOP ASSEMBLY ENSURE THAT THE MAINS POWER SUPPLY IS SWITCHED OFF AND THAT THE MAINS CABLE IS REMOVED.



AT-60 - Bottom View

CAUTIONS

THE AT-60 CONTAINS CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.

THE TOP ASSEMBLY IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING, ALWAYS PLACE THE TOP ASSEMBLY ON A SOFT, NON-ABRASIVE CLOTH.

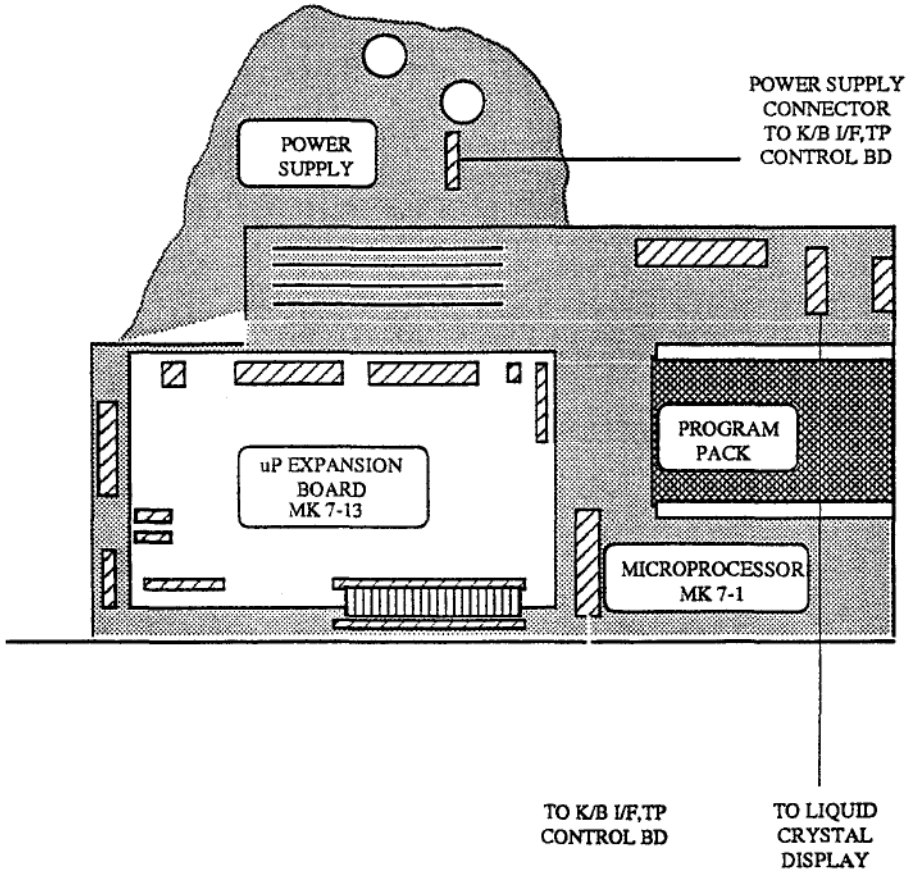
TAKE CARE NOT TO PLACE ANY STRAIN ON THE THREE CONNECTING RIBBON CABLES WHEN REMOVING THE TOP ASSEMBLY. ENSURE THAT THE CABLE ASSEMBLIES ARE NOT CRIMPED OR TWISTED AND THAT THE TOP ASSEMBLY IS NOT PLACED ON THE CABLE ASSEMBLIES.

Top Assembly (cont.)

Top Assembly Removal

The Top Assembly is mounted on the Base Assembly and is secured to the Base Assembly with six screws and washers; access to the screws is gained form the underside of the unit. To remove the Top Assembly, proceed as follows:

1. Remove all cable assemblies connected to the side and rear panels. Ensure that the mains cable is removed.
2. Taking care to secure the hinged LCD module so that it cannot swing open, turn the unit up-side-down to rest on the LCD module.
3. Unscrew the six retaining screws and washers that secure the two assemblies.
4. Grasping the top and bottom of the unit to ensure that the two assemblies cannot part, carefully return the unit to the upright position.
5. Gently lift the left-hand side of the Top Assembly sufficiently to gain access to the interconnecting cables, and disconnect the following:
   - the two ribbon cable connectors from the Microprocessor Board MK 7-1
   - the cable assembly to the Power Supply.
6. Gently lift the Top Assembly away from the Base Assembly and place on a soft cloth.


POWER SUPPLY
POWER SUPPLY CONNECTOR TO K/B I/F,TP CONTROL BD
uP EXPANSION BOARD MK 7-13
PROGRAM PACK
MICROPROCESSOR MK 7-1
TO K/B I/F,TP CONTROL BD
TO LIQUID CRYSTAL DISPLAY

Top Assembly Connectors

Top Assembly (cont.)

Top Assembly Replacement

To replace the Top Assembly proceed as follows:

1. Check that all boards and components are firmly secured. Check for loose screws. Ensure that no screws or foreign bodies are loose in the Base Assembly.
2. Inspect all the internal cable assemblies and ensure that they are in good condition and that no visible damage can be seen. Ensure that no cable assemblies are strained, crushed or caught.
3. Ensure that all connectors are firmly home.
4. Position the Top Assembly adjacent to the Base Assembly and without straining the ribbon cables, plug in the three interconnecting cable connectors in their relevant position on the Microprocessor Board.

   Note: It may be necessary to tilt the Top Assembly for the cable assemblies to reach.
5. Carefully position the Top Assembly on the Base Assembly.
6. Grasping the two assemblies to ensure that they cannot part, carefully turn the unit up-side-down and replace the six securing screws and washers. Return the unit to the upright position.

Checks and Tests After Replacing the Top Assembly

The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test but is intended to identify any faults that may be present after the unit has been reassembled. To carry out the general confidence check of the AT-60 proceed as follows:

1. Ensure that the voltage selector on the back panel is set for the required voltage and connect mains to the unit. Switch on the mains and ensure that the green mains LED on the hinged LCD Assembly, lights.
2. Switch the unit on by pressing the <ON> key on the Keyboard for approximately a second. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.
3. Using a small blunt instrument, press the red master reset button on the side panel.
4. Press <FNCT> <2> <2> and enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen.
5. Connect the ECG phantom to the ECG connector on the side panel and switch the phantom on. Ensure that a good ECG trace is displayed on the screen.
6. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality. Press <MAN START> and ensure that the print-out is accurate and of good quality.
7. Press the <AUTO START> key and wait approximately 10 seconds for the printout to commence. Ensure that the print-out is accurate and of good quality.
8. Connect the RS Test cable to RS-232 ports 1, 2 and 3 on the back panel and carry out the RS transmission test as detailed in Chapter 3.

Top Assembly (cont.)

9. Press the <PATIENT DATA> key and systematically press the keys:

   <QWERTZUIOP>, <ENTER>, <1234567890>

   Ensure that the entered data is correctly presented on the screen as entered. Press <ESC> exit from the patient data display.

10. Press the <BEGIN> key and ensure that the AT-60 indicates that an exercise test has commenced. Press the <STOP> key and ensure that a print-out is given.

11. Enter the required static parameter values. After resetting store the entered parameter values by pressing <FNCT <2> <6>.

    Note: Details of all parameters, parameter values, and the procedure to set them, is provided in the AT-60 Operating Manual.

12. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out). Switch the unit off and leave connected to the mains supply for eight hours to fully charge the battery.

13. Disconnect the mains power supply and leave the unit for 24 hours. Switch the unit on and ensure that all static parameters have been remembered. To ensure that the integrity of the battery, leave the unit switched on for 45 minutes and check that the battery LED does not start to flash in that time.

Microprocessor Board

Pre-requisites

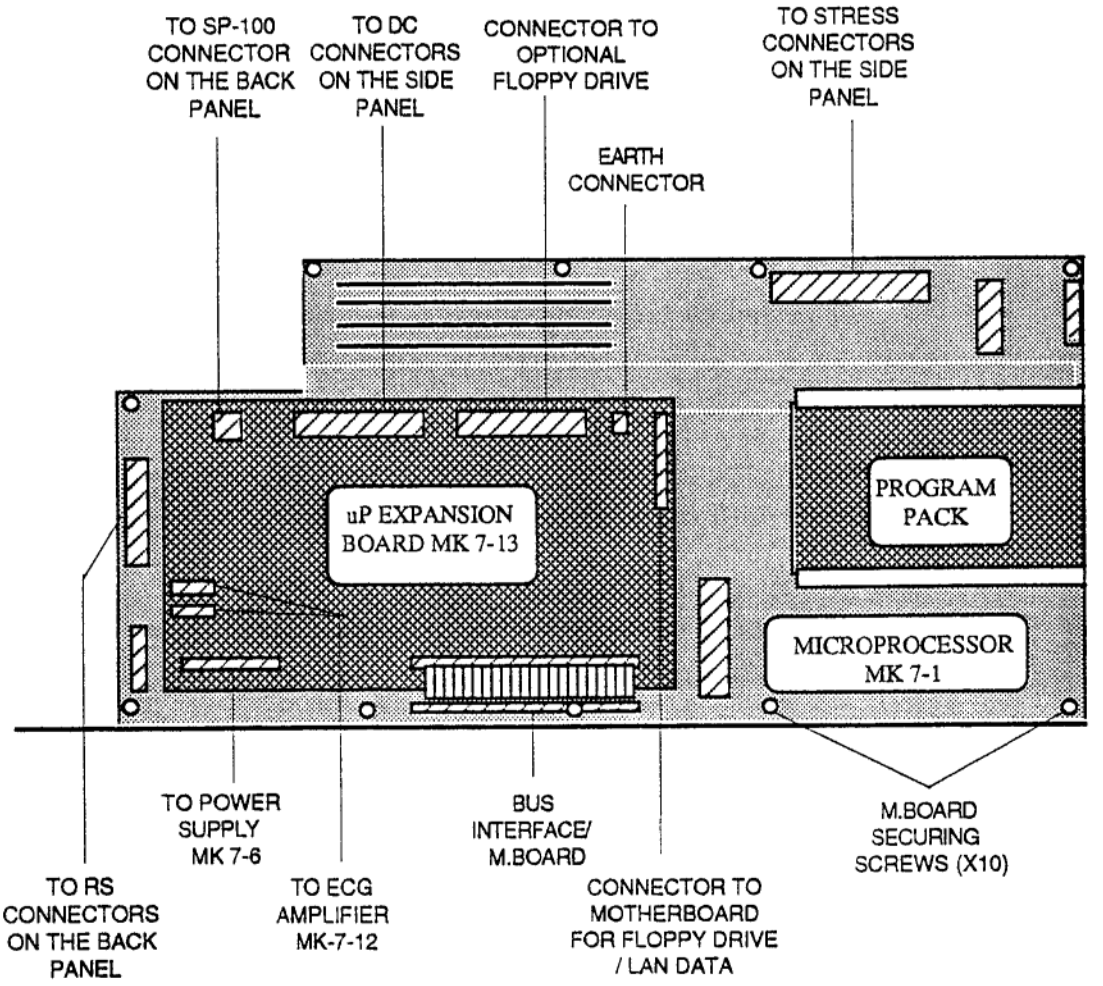
- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

Tools

- Cross-Bladed screwdriver

Parts

- Microprocessor Board MK 7-1. Part number as detailed in Chapter 5.


TO SP-100 CONNECTOR ON THE BACK PANEL
TO DC CONNECTORS ON THE SIDE PANEL
CONNECTOR TO OPTIONAL FLOPPY DRIVE
TO STRESS CONNECTORS ON THE SIDE PANEL
EARTH CONNECTOR
uP EXPANSION BOARD MK 7-13
PROGRAM PACK
MICROPROCESSOR MK 7-1
TO POWER SUPPLY MK 7-6
BUS INTERFACE/ M.BOARD
M.BOARD SECURING SCREWS (X10)
TO RS CONNECTORS ON THE BACK PANEL
TO ECG AMPLIFIER MK-7-12
CONNECTOR TO MOTHERBOARD FOR FLOPPY DRIVE / LAN DATA

Microprocessor Board (cont.)

Microprocessor Board Removal

The Microprocessor Board is secured to mounting brackets secured to the Base Assembly. To remove the Microprocessor Board proceed as follows:

CAUTION

THE MICROPROCESSOR BOARD CONTAINS CMOS COMPONENTS. ANTI-STATIC PRECAUTIONS MUST BE OBSERVED AT ALL TIMES.

1. Disconnect the following connectors from the Microprocessor Board:
   - Connector to the Bus Interface board
   - Connector to the Stress connectors on the side panel
   - Connector to the RS connectors on the Back Panel
2. Disconnect the following connectors from the Bus Interface:
   - The earth connector
   - Connector to the dc connectors on the side panel
   - Connector to the SP-100 connector on the Back Panel
   - Connector to the ECG Amplifier Board connector
3. Unscrew and remove the ten Microprocessor Board securing screws.
4. Gently hinge the board away from the Base Assembly so that access is gained to the power supply connector on the Power Supply Board. Disconnect the connector and remove the Microprocessor Board.

Note 1: The Bus Interface is mounted on spacers on the Microprocessor Board; removal and replacement instructions for the Bus Interface are provided in the next Paragraph.

Note 2: The Program Pack is mounted in slides on the Microprocessor Board and connects directly with it. Removal and replacement instructions for the Program Pack are provided in this chapter.

Microprocessor Board (cont.)

Microprocessor Board Replacement

Note: The Bus Interface Board MK 7-12 must be secured to the Microprocessor Board before installing the Microprocessor Board.

To replace the Microprocessor Board proceed as follows:

1. Position the Microprocessor Board and thread the ribbon cable to the Power Supply Board MK 7-6, through the aperture in the support plate; take care not to strain the cable. Connect the cable to the power supply connector. Secure the Processor Board with the ten securing screws.
2. Reconnect the following connectors from the Microprocessor Board:
   - Connector to the Bus Interface Board
   - Connector to the Stress connectors on the side panel
   - Connector to the RS connectors on the Back Panel
3. Reconnect the following connectors from the Bus Interface:
   - The earth connector
   - Connector to the dc connectors on the side panel
   - Connector to the SP-100 connector on the Back Panel
   - Connector to the ECG Amplifier board connector
4. Slide in, and secure the Program Pack as detailed in Paragraph six (if removed)
5. Check that all boards and components are firmly secured. Check for loose screws. Ensure that no screws or foreign bodies are loose in the Base Assembly.
6. Inspect all the internal cable assemblies and ensure that they are in good condition and that no visible damage can be seen. Ensure that no cable assemblies are strained, crushed or caught.
7. Ensure that all connectors are firmly home.

Checks and Tests After Microprocessor Board Replacement

When the unit is reassembled after Microprocessor Board replacement, the functional checks detailed on page 4.21 must be carried out to ensure the integrity of the unit.

Bus Interface AT-60

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed above and all external cable assemblies disconnected.
- The Microprocessor Board MK 7-1 must be removed as detailed above and all connectors and cable assemblies to the Bus Interface board disconnected.

Tools

- Cross-Bladed screwdriver

Parts

- Bus Interface AT-60 MK 7-12. Part number as detailed in Chapter 5.

Bus Interface Removal

To remove the Bus Interface Board unscrew the six screws securing the board to the Motherboard, and lift the board away from the Motherboard.

Bus Interface Replacement

The replace the Bus Interface position the board on the Microprocessor Board and secure using the six captive screws.

Note: Connections to the Bus Interface board are detailed in the Microprocessor Board replacement procedure.

Checks and Tests After Bus Interface Replacement

Carry out the checks and tests detailed for the Top Assembly on page 4.21.

Program Pack (and software modules)

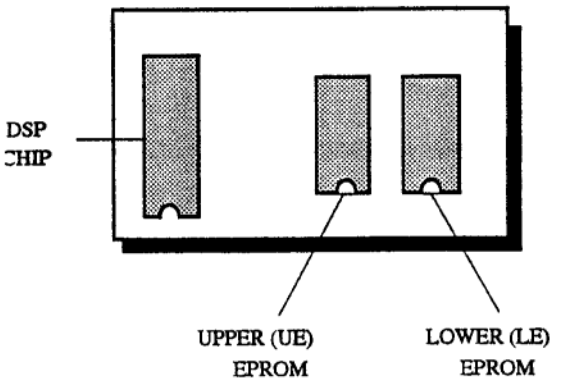
Pre-requisites

Tools

- Cross-Bladed screwdriver

Parts

- Program Pack with the correct software installed, or the software EPROM or DSP modules. Part numbers as detailed in Chapter 5.



Program Pack

Note: The EPROM software is available in various languages indicated by the label on the EPROM. The second letter in brackets indicates the language as follows:

ENG - English

GER - German

SWE - Swedish

ITA - Italian

FRE - French

SPA - Spanish

Program Pack (and software modules) (cont.)

Program Pack (and program EPROM and DSP) Removal

CAUTION

THE PROGRAM PACK CONTAINS STATIC SENSITIVE CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.

To remove the Program Pack remove the two Program Pack retaining screws and, using the attached handle, gently ease the Program Pack away from the connector.

To remove an EPROM or DSP chip from the board, gently and evenly push the two end clamps away from the module; the chip will lift from the socket. When the chip is free from the clamps, gently ease it away from the socket.

Program Pack (and program EPROM and DSP) Replacement

Note: The software version of a program PROM or DSP chip is written on the label attached to the chip. Before replacing a program chip ensure that it is the correct software version for the application.

To replace a PROM or DSP chip, position it above the socket so that the chip alignment notch is matched with the socket alignment notch. Gently and firmly push home until retained by the module clamps.

To replace the Program Pack, slide the pack in the board guides and gently and firmly push home. Secure in position with the two retaining screws.

Checks and Tests After Program Replacement

1. Switch the unit on by pressing the <ON> key on the Keyboard for approximately a second. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.

2. Switch the unit on and check that the correct software version, as stated on the label is installed. To do this press the key sequence:

   <ECG> <7> <.>

   The software version is displayed on the LCD. (See Chapter 3 for software details).

3. Carry out the AT-60 functional check detailed on page 4.21.

ECG Amplifier Board

Pre-requisites

Tools and Test Equipment

- Cross-Bladed screwdriver

Parts

- ECG Amplifier board. Part number as detailed in Chapter 5.

ECG Amplifier Board Removal

The ECG Amplifier is mounted in slides and plugs directly into the Base Unit. Access to the ECG Amplifier is gained from the Side Panel. To remove the ECG Amplifier loosen the two board retaining screws and gently ease the board away from the connector.

Note: If difficulty is experienced in removing the board connect a spare D-type plug to the ECG connector to use as a handle.

TAKE CARE NOT TO DAMAGE THE CONNECTOR.

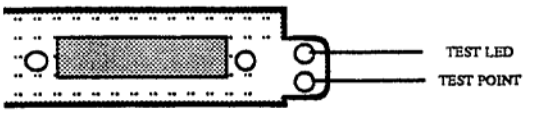
ECG Amplifier Board Replacement

To replace the ECG Amplifier board, slide the board into the board guides and gently and firmly push home. Secure in position with the two retaining screws.

Checks and Tests after Replacement

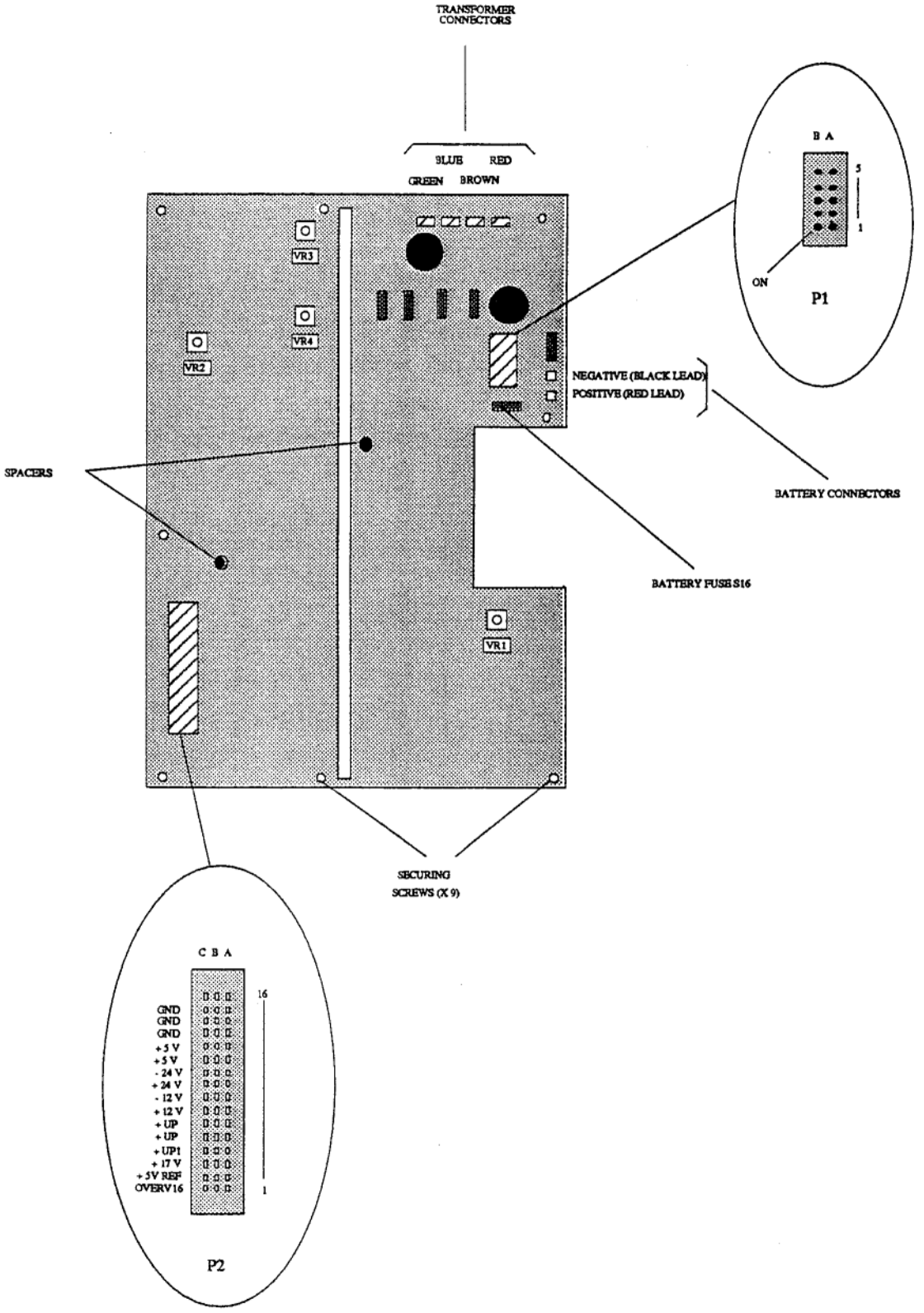
To prove the integrity of the replaced board carry out the following functional check procedure:

1. Switch on the unit and connect a Schiller patient cable to the ECG connector. Carry out a cable test by inserting each lead in turn into the lead test point. Ensure that the green test LED lights when a patient lead is inserted.



2. Connect a suitable patient simulator to the ECG connector and carry out a resting ECG. Ensure that all the leads can be displayed on the LCD.

Note: The procedure to carry out an ECG test is given in the AT-60 operating manual


TRANSFORMER CONNECTORS
BLUE
RED
GREEN
BROWN
VR3
VR4
VR2
VR1
B A
5
1
ON
P1
NEGATIVE (BLACK LEAD)
POSITIVE (RED LEAD)
SPACERS
BATTERY CONNECTORS
BATTERY FUSE S16
SECURING SCREWS (X 9)
C B A
16
1
GND
GND
GND
+5 V
+5 V
- 24 V
+ 24 V
- 12 V
+ 12 V
+ UP
+ UP
+ UP1
+ 17 V
+ 5V REF
OVERV16
P2

Power Supply board

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.
- The Microprocessor Board MK 7-1 and Bus Interface MK 7-12 must be removed as detailed previously.

Tools and Equipment

- Cross-Bladed screwdriver
- Small flat-bladed screwdriver
- Socket wrench (5 mm) for spacers
- Digital Voltmeter

  Note: It is recommended that power measurements are taken on the Doppler power socket. To do this pointed needle voltmeter test leads will be required. Alternatively a suitable 32-way plug could be fabricated to enable crocodile leads to be used.

Parts

- Power Supply MK 7-6. Part number as detailed in Chapter 5.

WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Power Supply Board Removal

To remove the Power Supply board proceed as follows:

1. Disconnect the flying leads to the mains transformer and to the battery.
2. Unscrew the two Microprocessor Board Spacers and remove.
3. Unscrew the eight securing screws holding the Power Supply board and remove the board.

Power Supply Board Replacement

To replace the Power Supply proceed as follows:

1. Position the board and secure to the Base Assembly with the eight securing screws.
2. Screw the two Microprocessor Board spacers to the Base Assembly.
3. Connect the four Mains Transformer leads and the two leads to the battery.
4. Check and adjust all the power supplies generated by the Power Supply board as detailed below.

Power Supply board (cont.)

Checks and Tests after Power Supply Board Replacement

After assembly, connect the mains supply to the unit and ensure that the green mains supply LED is lit. Switch the unit on and ensure that the LCD is lit and that meaningful data is displayed. Press the <PRINT SCREEN> key. Ensure that the printer functions.

Switch the unit off but leave the mains connected. Leave the battery to charge for eight hours. Disconnect the mains and run the unit on battery power for 45 minutes (without using the printer) to ensure that the battery charge circuit is functioning. Ensure that the battery LED lights when running on battery power. Ensure that the battery LED flashes when the battery voltage falls below 11.2 V and that the unit switches off when the battery voltage falls below 9.2 V.

Power Supply Adjustments

The power supplies generated by the Power Supply board can be checked in isolation; it is not a requirement that the unit has to be assembled to check the power supplies. If the power supplies are checked when the Power Supply is connected to the Processor board however, a more accurate measurement may be achieved.

No test measuring points are present on the Power Supply board and measurements must be taken on the components themselves or on connectors. Most of the supplies appear on the Doppler connector P2 and it is recommended that this connector is used for measurement. To take measurements on this connector needle test leads are required. To provide more secure attachment of the test leads, it is recommended that an open-backed compatible plug is fabricated to facilitate the attachment of crocodile leads.

Notes: The 13.8 V battery charge voltage is not present on the P2 connector and voltage measurement must be made from the battery fuse.

No adjustment is possible for the switching regulators (5V, 12V, -24V).

The battery indicator off-set can only be adjusted when the unit is assembled.

WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THE POWER SUPPLY. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENTS.

On Signal Simulation

A latch circuit exists on the power supply to switch the Power Supply on and off. If the Power Supply board is checked in isolation an on signal must be generated to simulate the on signal from the processor. The on signal is an active low. To simulate the on signal, proceed as follows:

1. Connect mains to the unit and switch the mains on.
2. Using a suitable lead, connect ground to Plug P1 pin 1B, and hold for 2 seconds. The Power supply will now be latched on and all generated power supplies can be checked for the correct voltage.

Power Supply board (cont.)

Printer Voltage (+24V) Adjustment

To check and adjust +24V supply proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at socket P2 pin 9. Adjust VR1 to achieve a voltage of +24V.

Battery Charge Voltage (13.8V) Adjustment

This voltage can only be accurately adjusted when the battery is fully charged. To check and adjust the battery charge voltage proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at the battery fuse SI6. Adjust VR3 to achieve a voltage of +13.8 V.

Control Voltage (+17V) Adjustment

To check and adjust the +17 V supply proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at socket P2 pin 3A or pin 3C. Adjust VR4 to achieve a voltage of +17V.

   Note: When working from battery power this voltage is approximately 0.5V higher.

Battery Low Voltage Detection Adjustment

The low voltage detection circuit monitors the battery voltage and sets the battery low and the battery down signals. These signals are used to give a visual indication that the battery voltage is getting low (battery LED flashing) and to switch off the unit when the battery voltage is below a minimum level. The nominal battery voltage at which the Battery Low signal become active is 11.3V. The nominal voltage at which the Battery down signal becomes active is 9.2V.

Service Note: A delay circuit is provided on the Power Supply board to compensate for high power peaks eg printing, which could `trick´ the battery voltage detection circuit into thinking that the battery power is low. It ensures that the when the unit is working from the battery, the battery LED does not flash or the unit switch off, when the printer is activated.

This compensation circuit is linked with the battery low voltage detection circuit. If the battery LED flashes, or the unit switches off when printing on battery power, it can indicate that this adjustment is incorrectly set.

To carry out this procedure the unit must be assembled (and the Processor board installed) with the Top Assembly placed by the side of the Base Assembly and all cable assemblies between the two assemblies, connected.

Power Supply board (cont.)

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To adjust the potentiometer for the low voltage detection circuit proceed as follows:

1. Ensure that the mains supply is disconnected and remove the red and black battery leads from the Power Supply board. Connect a stabilised variable power supply to the two battery bayonet connectors (on the Power Supply board).
2. Set the power supply to +12V and switch the AT-60 on. Ensure that the unit switches on and that the Battery LED, next to the LED, is lit.
3. Reduce the power supply to 11.35V and ensure that the LED indicator lights continuously. Reduce the power supply further to 11.25V. Ensure that the LED indicator is now flashing. Adjust VR2 as necessary.
4. Reduce the power supply to 9.2V and ensure that the Battery LED continues to flash. Slowly reduce the power to 9.15V. Ensure that the unit switches off and that the battery LED is extinguished by 9.15V. Adjust VR2 if necessary.

Note: Adjustment of VR2 affects both the battery low signal and the battery down signal and it may not be possible to have both these signals exactly within tolerance at the same time. When this is the case, set VR2 so that the battery low threshold is within tolerance. The battery low signal is a nominal value and not critical within 11V and 11.3V.

Mains assembly

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

Tools

- Narrow, blunt instrument for unlatching the assembly catches.
- Small flat-bladed screwdriver

Parts

- Mains Assembly. Part number as detailed in Chapter 5.

WARNING

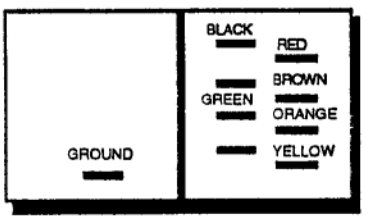
ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Mains Assembly Removal

To Remove the assembly proceed as follows:

1. Disconnect the crimped flying lead connectors on the back of the assembly.
2. Using a narrow blunt instrument, unlatch the two bottom retaining catches. Unlatch the top catch and remove the assembly from the Mains Assembly securing bracket on the Base Assembly.

   Note: The Mains Assembly is retained in position with three tensioned catches. Access to the two bottom catches is gained from the bottom of the Base Assembly via two access holes.



Mains assembly (cont.)

Mains Assembly Replacement

1. Ensure that the mains voltage selector is set to the correct voltage for the application as indicated by an arrow in the selector and fuse sub-assembly. If the voltage is not set for the required voltage, proceed as follows:

   ◊ Using a small flat-bladed screwdriver gently prise the selector and fuse sub-assembly away from the main assembly.

   ◊ Lift the retaining clip securing the voltage plate and remove the plate.

   Note: The plate has contacts which are pushed into tensioned connectors; a small screwdriver may be required to prise the plate away from the connectors.

   ◊ Replace the voltage plate by pushing fully home. Ensure that the correct voltage is displayed in the front and top `voltage windows´.

   ◊ Click the sub-assembly back in place in the Mains Assembly.

Note: The fuse sub-assembly containing the mains fuses, is positioned under the voltage plate and is removed and replaced in the same way as above.

CAUTION

IT IS POSSIBLE TO INSERT THE MAINS ASSEMBLY UPSIDE DOWN. WHEN REPLACING THE ASSEMBLY ENSURE THAT THE MAINS ON/OFF SWITCH IS UPPERMOST WITH THE MAINS CONNECTOR UNDER THE ON/OFF SWITCH.

2. Push the Mains Assembly into the Base Assembly until the catches engage with the bracket. Ensure that the assembly is firmly in position.

3. Reconnect the crimped cables.

Checks and Tests after Replacement

After assembly connect mains to the unit and ensure that the green power LED lights.

Mains Transformer

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

Tools

- Cross-bladed screwdriver

Parts

- Mains Transformer. Part number as detailed in Chapter 5.

WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Mains Transformer Removal

To remove the Mains Transformer proceed as follows:

1. Disconnect the four power supply bayonet connectors on the Power Supply board.
2. Disconnect the flying lead connectors to the Mains Assembly.
3. Unscrew the centre screw of the Mains Transformer, and remove from the Base Assembly.

Mains Transformer Replacement

To replace the mains transformer proceed as follow:

1. Position the Transformer and secure to the Base Assembly with the centre screw.
2. Connect the flying leads to the Power Supply and to the Mains Assembly. (See the Power Supply paragraph and Mains Assembly paragraph respectively, for the connector colours).

Checks and Tests after Replacement

After assembly connect mains to the unit and ensure that the green power LED lights.

Connector Panels

There are three connector panels on the AT-60. All are secured to panels on the Base Assembly by screws.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

Tools

- Cross-Bladed Screwdriver

Parts

- Details of the connector panel part numbers are given in Chapter 5.

Connector Panel Removal and Replacement

To remove a connector panel, disconnect the relevant cable assemblies and unscrew the panel from the Base Assembly. To Replace a connector panel secure it with the securing screws and connect the cable assemblies.

Checks after Replacement

After replacing a connector panel replace the Top Assembly and carry out the functional checks detailed on page 4.21.

Keyboard I/F, TP Control and Audio Amp Board

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

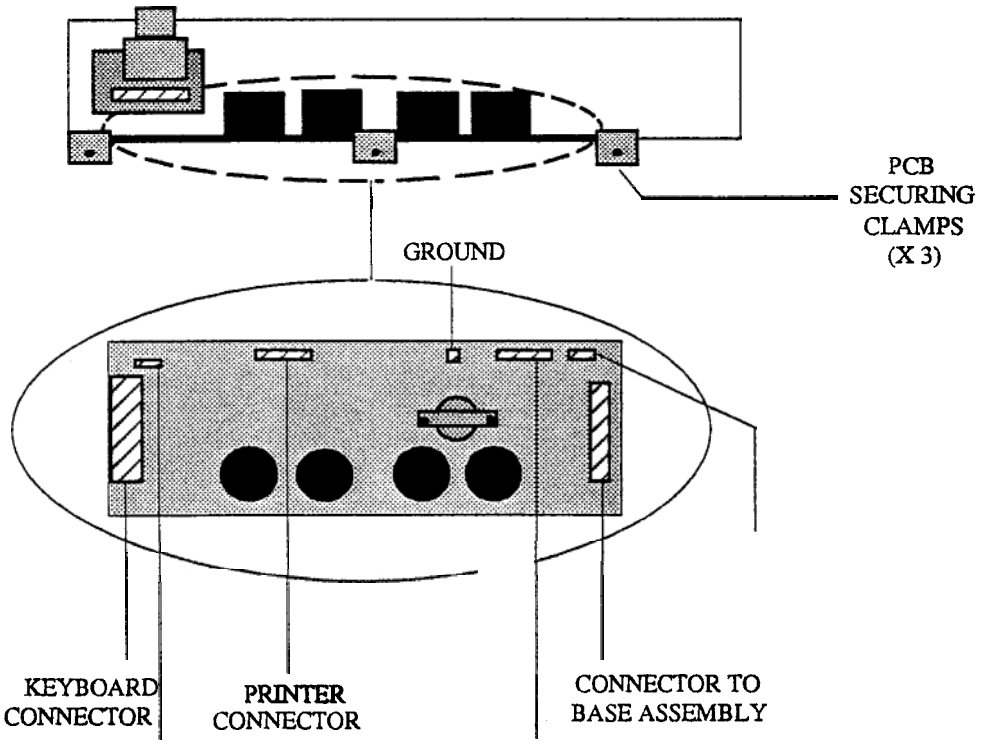
Tools and Test Equipment

- Cross-Bladed screwdriver
- Flat-Bladed screwdriver

Note: Two printer control pre-sets are present on this board. These pre-sets are factory set and should not require adjustment. If adjustment is necessary however, a multimeter capable of measuring 5 Vdc and 1 A is required.

Parts

- Keyboard I/F, TP Control, Audio Amp Board MK-7-5. Part number as detailed in Chapter 5.



Chapter 5
Spare Parts

Contents

Introduction	*5.2*
Module Identification	*5.3*
AT-60 Spare Modules	*5.5*
Disposables	*5.6*
Accessories	*5.7*
Dedicated Test Equipment and Special Tools	*5.8*

Introduction

This Chapter gives the part numbers for modules that can be replaced by the service engineer. The part numbers for disposables, accessories and dedicated test equipment are also included.

When ordering state that the module required is for an AT-60 unit and provide the following:

- Part Title
- Part Number
- Software Version * (if applicable)
- Serial number of the unit *
- Your company address and a contact name

  * The serial number can be found on the back panel. The software version of the unit is found on the software screen (details in Chapter 3). The serial number is especially necessary when ordering mechanical parts to ensure that the correct version is identified by the order processing department

Additionally if you are returning a faulty module the following information, in as much detail as possible, will speed repair:

◊ the exact nature of the fault

◊ the circumstances, and function being carried out, when the fault occurred

IT IS RECOMMENDED THAT RETURNED MODULES ARE SENT BY REGISTERED POST.

IMPORTANT

ALL BOARDS AND STATIC SENSITIVE MODULES MUST BE RETURNED IN A SEALED STATIC SHIELDING BAG. NO RESPONSIBILITY CAN BE ACCEPTED FOR MODULES NOT SENT IN THIS WAY

The address to send your order is:

Schiller AG

Sales Department (Order Processing)

Altgasse 68

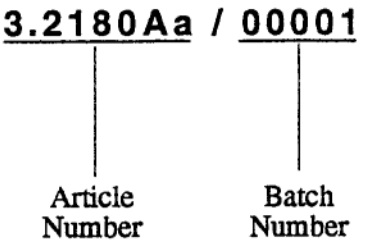
CH-6340 Baar

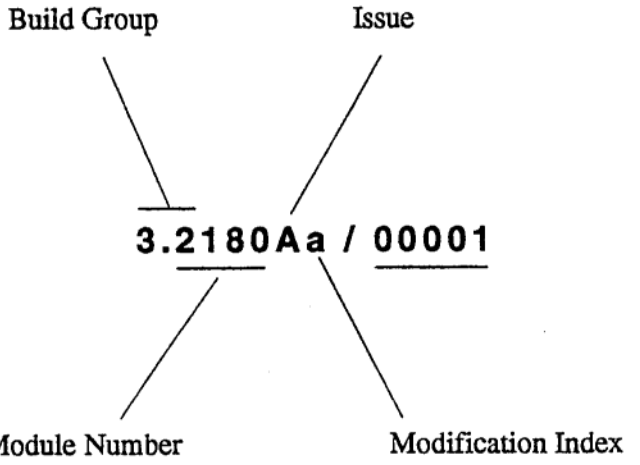
Switzerland

Introduction (cont.)

Module Identification

Every module has a unique part number. The number is either stencilled on the module or printed on an attached label. The module numbers are arranged as follows:





When ordering a module, only the article number has to be stated (without the modification index). The Batch number is a manufacturing identification number and need not be stated unless a module is suspected of having a manufacturing fault.

The article number is divided as follows:

Build Group Number	This number identifies the type of module or module group, for example electrical (PCB), mechanical, component etc.
Module Number	The individual module number
Issue Letter	This is always an upper case letter and gives the issue state of the module
Modification Index	This lower case letter gives the modification or build state of the module. It is applicable only for the specific Issue

Introduction (cont.)

The documentation associated with a module, is identified by a letter in place of the module build group number. For example the processor board for the CARDIOVIT AT-60 without the Spirometry option, has the article number **3.2180Ga.**

The Circuit Diagram is **S.2180Ga,**

The Block Diagram is **B.2180Ga**

The Component Layout is **D.2180Ga.**

The categories are as follows:

DOCUMENT	IDENTIFICATION LETTER
CIRCUIT DIAGRAM	S
BLOCK DIAGRAM	B
COMPONENT LAYOUT	D
TEST DOCUMENTATION	P
ASSEMBLY DOCUMENTATION	F

Note that the Test Documentation and Assembly Documentation is usually available for internal use only.

AT-60 Spare Modules

PART DESCRIPTION	PART NUMBER
KEYBOARD MK 7-31 ENGLISH	3. 2204Aa
KEYBOARD MK 7-31 GERMAN	3. 2203Aa
KEYBOARD MK 7-31 FRENCH	3. 2205Aa
KEYBOARD MK 7-31 ITALIAN	3. 2206Aa
ECG BOARD MK 7-20C	3. 2223CD
VIDEO/LCD CONVERTER BOARD MK 7-91	3. 2216Ea
KEYBD I/F, TP CONTROL AND AUDIO AMPLIFIER BOARDMK 7-5E	3. 2202EB
MICROPROCESSOR BOARD MK 7-1K	3. 2180KA
POWER SUPPLY BOARD MK 7-6C	3. 2192CF
INTERFACE BOARD MK 7-12	3. 2198Aa
THERMAL PRINTER (Complete with Print Head and Motor)	3.900317
THERMAL PRINT HEAD	4. 140113
THERMAL PRINTER MOTOR	3.900303
LCD 640 X 480	4. 600037
LEAD ACID BATTERY	4. 350005
MAINS MODULE (COMPLETE)	4. 270004
MAINS TRANSFORMER	4. 320085

Disposables

DESCRIPTION	PART NUMBER
PRINTER PAPER	2.157010
ELECTRODE GEL 100 mL	2. 158005

Accessories

DESCRIPTION	PART NUMBER
GROUND CABLE	2. 310005
POWER CABLE (D)	2. 300002
ELECTRODE SET COMPRISING FOUR EXTREMITY STAINLESS STEEL ELECTRODES WITH RUBBER STRAPS. SIX PRECORDIAL SUCTION ELECTRODES AND ELECTRODE GEL	2. 000041
PATIENT CABLE, 3.5 m	2. 400055

Dedicated Test Equipment and Special Tools

DESCRIPTION	PART NUMBER
RS TEST CABLE ASSEMBLY	2. 310 042
HEXAGONAL CROSS-BLADED SCREWDRIVER USED FOR THE REMOVAL AND REPLACEMENT OF THE PRINT HEAD	SCHILLER NUMBER 4.950074. MANUFACTURED BY WERA, NUMBER - **WERA** 367 TX 210180

Chapter 6
Technical Data

Contents

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Pulmonary Function SP-100/R (Option)	***6.10***
Accessories for Pulmonary Function Testing	*6.10*

Technical Data

General

Dimensions (l/w/h):	400 x 360 x 160 mm
Weight:	approx. 12 kg
Power supply requirements:	110 / 130 / 220 / 240Vac, 50 / 60Hz
Power consumption:	20 to 80VA
Battery:	12V, 1.8 to 2.3Ah (178 x 34 x 65mm)
Printing process:	high-resolution thermal printhead, 8 dots per mm (amplitude axis), 40 dots per mm (time axis) @ 25mm/s
Paper speed:	2.5 / 5 / 10 / 12.5 / 25 / 50 / 100 mm/s
Sensitivities:	2.5 / 5 / 10 / 20mm/mV
Recording tracks:	1 - 12 channels, positioned at optimal width on 200 mm, automatic baseline adjustment
Chart paper:	thermoreactive, Z-folded, 21cm wide, 130m long, perforation for format A4 (21 x 28 cm)
Liquid crystal display:	Backlighted liquid crystal display for ECG monitoring and alphanumeric information
	Resolution: 640 x 480 dots; viewing angle adjustable
Frequency range of the digital recorder:	0 Hz - 150 Hz (IEC); 0 Hz - 150 Hz (AHA)
Test socket for patient cable:	for testing of electrode cables for interruptions and short-circuit; control light indication
Patient input:	fully floating and isolated, defibrillation protected
Patient leakage current:	less than 5 µA
Safety standard:	CF according to IEC
Protection class:	according to IEC, VDE and SEV
Environmental conditions:	temperature, operating: 10° to 40 °C
	temperature, storage: 0° to 50°C
	relative humidity: 15 to 85 % (non-condensing)
Control panel and keyboard:	splashproof pad keys
Leads:	Standard / Cabrera / Frank X Y Z / Nehb / V7, V8, V9 / further combinations to be programmed by user

Technical Data (cont.)

Automatic lead programs:	3, 6, or 12 channel representation on one or two pages A4 (25, 50, 100 mm/s)
	Versions M and C: average complexes of the 12 standard leads (25 or 50 mm/s) and 10s rhythm strip (1 or 3 leads); Vector loops from the standard leads
	Version V: graphic representation of Frank X, Y, Z vector loops (for M and C versions)
Data record:	Listing of ECG recording data, date and time of recording, patient data, etc.
	Versions M and C: ECG measurement results (intervals, amplitudes, electrical axes), average complexes with optional meaurement reference markings
	Version C: ECG interpretation statements
Long-term rhythm recordings:	2 leads, 20 min / page
	1 lead, 60 min / page
	1 lead, 30 min / page
	1 lead, 10 min / page
	1 lead, 5 min / page
Exercise ECGs with final report:	automatic control of bicycle ergometer and treadmill (user programmable)
	Final report showing trendplots of heart rate, load and blood pressure, physical working capacity (PWC 150, PWC 170, PWC max.)
	Versions M and C: QRS and ST measurements
ECG storage:	Output memory for 10s 12 / 15-lead ECG
	Circular input memory for 10s 12 / 15-lead ECG: The last 10s ECG can be copied from input memory to output memory by pressing one key.
	Every ECG can be copied from output memory any number of times.
Myogram filter (muscle tremor filter):	adjustable at 25 or 35 Hz, only effective for printed ECG
Line frequency filter:	distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of adaptive digital filtering

Technical Data (cont.)

ECG amplifier:

simultaneous, synchronous recording of all 12 active electrode signals (= 15 leads)

sampling frequency: 4kHz

digital resolution: 2.5 µV (min)

dynamic range: ± 16 mV

max. electrode potential: ± 300 mV

frequency response: 0 to 350Hz (-3 dB)

common mode rejection: > 100dB / 50 or 60 Hz

input impedance: >100 MOhm

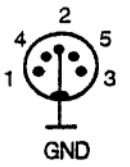
pacemaker detection / measurement:

- detection voltage range ± 1mV to ±500mV
- measurement duration range 0.1 to 5ms

Connectors

Stress Test Interface

Input impedance: > 100 kOhm

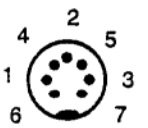


Pin 1	RPM Input: 100 RPM/V
Pin 2	GND
Pin 4	Load input: 100 W/V
Pin 5	Load output: 100 W/V

Data I/O

TTL logic level: 5 Vdc

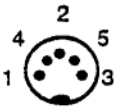
Note: max. non-destructive voltage +15 Vdc, or -10 Vdc (2.5 kV static discharge)



Pin 1	QRS trigger
Pin 2	GND
Pin 3	footswitch (contact to GND = START)
Pin 4	TM DN
Pin 5	TM UP

Connectors (cont.)

Connector for External Keyboard



Pin 1	PCKBD
Pin 2	PCKBCLK
Pin 3	PCKBRES
Pin 4	PCKBGND
Pin 5	PCKB+5

Video Connector

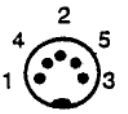
D sub, 15 pole, High-density, female:

Resolution:	640 x 480 dots	
Input signals	horizontal sync.:	TTL (positive)
	vertical sync.:	TTL (negative)
	video:	0 to 0.7V
Scanning frequency :	horizontal:	31.3 kHz
	vertical:	60 Hz
Pin Connections:	Pin 2	Video
	Pin 11	DISP
	Pin 5	Test
	Pin 13	H-SYNC
	Pin 7	Video GND
	Pin 14	V-SYNC
	Pin 9	D CLK
	Pin 10	Sync GND

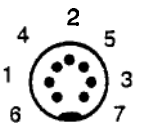
Connectors (cont.)

Experimental Inputs

Connectors DC 1/2, DC 3/4, and DC 5/6



CONNECTOR DC 1/2		CONNECTOR DC 3/4		CONNECTOR DC 5/6	
Pin	Signal	Pin	Signal	Pin	Signal
1	DC1 +	1	DC3 +	1	DC5 +
2	AGND	2	AGND	2	AGND
3	DC2 +	3	DC4 +	3	DC6 +
4	DC1 -	4	DC3 -	4	DC5 -
5	DC2 -	5	DC4 -	5	DC6 -



Pin 1 DC 1 +

Pin 2 AGND

Pin 3 DC 2 +

Pin 4 DC 3 +

Pin 5 DC 4 +

Pin 6 DC 5 +

Pin 7 DC 6 +

Connectors (cont.)

RS-232 (V24) Serial Interface (Interface numbers 1, 2 and 3)

Protocol:		Asynchronous
Baud Rate:		75 to 153600 Baud
Byte Format:		1 start bit, 8 data bits.
		0 or 1 parity bit (+ or -), programmable
		1 / 1.5 / 2 stop bits, programmable.
Transfer Control:		by means of DTR, DSR, CTS, RTS
Connection Socket:		3 x D subminiature (9 pole female), wired as DTE (Data Terminal Equipment).
Pin Connections:	Channel 1, 2, 3:	Pin 3 TXD1 O (output data)
		Pin 2 RXD1 I (input data)
		Pin 7 RTS1 O (request for output)
		Pin 8 CTS1 I (ready for output)
		Pin 6 DSR1 I (transfer unit ready)
		Pin 4 DTR1 O (AT-60 ready)
		Pin 5 GND

RS-422 Serial Interface

Protocol:	Asynchronous
Baud Rate:	75 to 153600 Baud
Byte Format:	1 start bit, 8 data bits.
	0 or 1 parity bit (+ or -), programmable
	1 / 1.5 / 2 stop bits, programmable.
Transfer Control:	None
Connection Socket:	1 x D-sub, 9 pole
Pin connections:	Pin 1 GND
	Pin 2 TXC +
	Pin 3 TXC -
	Pin 4 RXC +
	Pin 5 RXC -
	Pin 6 RXD +
	Pin 7 RXD -
	Pin 8 TXD +
	Pin 9 TXD -

Pulmonary Function SP-100/R

Method of Measurement:		pneumotachometer
Measurement Ranges:		Flow: 0 to ± 15 l/s;
Volume:		0 to ± 11 litres
Measurement Accuracy:		± 2%
Flow Impedance:		less than 0.5 mbar * s/l at 10 l/s
Measured Values:		VC, ERV, IRV, TV, FVC, $FEV_{0.5}$, $FEV_{1.0}$, $FEV_{3.0}$, $FEV_{0.5}$/VC, $FEV_{1.0}$/VC, $FEV_{3.0}$/VC, $FEF_{0.2-1.2}$ (litres), $FEF_{25-75\%}$, $FEF_{75-85\%}$, PEF, $MEF_{75\%}$, $MEF_{50\%}$, $MEF_{25\%}$, MV, MVV, FIVC, $FIV_{1.0}$, $FIV_{1.0}$/FIVC, $FIV_{1.0}$/FVC, PIF, $MIF_{50\%}$.
		Comparison pre/post medication possible.
Prediction Equation:	Adults:	ECCS / Berglund / Finnish / Indian / Morris / Crapo / Knudson
	Children:	Quanjer & Tammeling / Indian / Knudson

Accessories for Pulmonary Function Testing

Standard accessories	Pneumotacho sensor SP-100
	Disposable cardboard mouthpieces
	Nose clips
	Filters
	Spirometer board for the CARDIOVIT AT-60 *
	Spirometer software for the CARDIOVIT AT-60 *
Optional Accessories	Calibration pump

Chapter 7
Glossary

Contents

Introduction	***7.2***
Acronyms	***7.3***

Introduction

The following list provides a glossary of the important signals and acronyms used in the circuit diagrams for the SCHILLER instruments. They will not all apply to the AT-60.

Only abbreviations that are specific to SCHILLER equipment are included here. General electrical and electronic abbreviations are not included.

Acronyms

..OS	Offset signal (on the ECG amplifier)
A(1..n)	CPU Address Bus.
ALBEEP	Alarm beeper signal to the audio amplifier. The frequency of this signal is about 1000 Hz.
ANA1, ANA2	Analog input from the experimental inputs DC1 and DC2.
AS	Address strobe
BATT	Signal to CPU indicating battery operation
BATTLC	Analog signal to the processor giving the charge condition of the battery.
BATTV	Battery voltage - analog signal from the power supply used by the processor to assess battery or mains operation.
BLOW	Battery less than 11.3V. LCD flashes when this signal is active. When the battery voltage drops to below approximately 9.4V the unit is switched off. These values apply to equipment with 12 V battery. For other equipment the limits are different.
CHAD ..	ECG signal multiplexer control signals (on the ECG Amplifier)
CIF(0..16)	Communication interface. General control signals for the communication interface circuits.
CI(0..10)	RS interface control lines - input.
CO(0..10)	RS interface control lines - output.
CL1	19 kHz LCD latch pulse.
CL2	3.11 MHz LCD clock frequency.
CLK..	Clock Signal. The number following the CLK indicates the frequency. For example CLK 19 indicates a frequency of 19 MHz.
CS..	Chip select. The general format of the chip select signals is CS followed by some characters. The characters indicate the device to which the chip select signal appertains. For example CSRTC is the chip select signal for the real time clock and CSEPROM is the select signal fot the EPROM etc.
CTS	Clear to send. General signal used in data communication.
D (0..15)	Data Bus
DACWR	Digital / analog converter wire.
DIO..	Data input/output on the Data I/O connector
DMUX	Data multiplexer.
DRAM	Dynamic RAM
DRC(0..6)	Dynamic RAM control.
DS..	Data strobe.

Acronyms

DSP..	Digital signal processor (on program pack).
DTACK	Transfer data acknowledge. Bus signal to acknowledge transfer of data.
DTR	Outgoing serial data, turns modem on.
ECG1	ECG in - serial ECG data to the CPU sent over the optical interface.
ECGMUX	The multiplexed ECG signal from the ECG amplifier.
ECGO	ECG out - serial ECG amplifier control data from the CPU sent over the optical interface.
EF	Empty flag.
EJCT	Eject (paper tray).
EKGRES	Reset signal to the ECG Amplifier. This signal resets the ECG Amplifier to recenter the ECG image on the LCD.
FIFOR	First in first out read.
FLM	Control signal for frame synchronisation of the LCD.
FPIN	Input for floating point co-processor.
FWR	Flag read / write.
HREN	Output enable signal for thermal print head data (History enable).
HSYNC	Horizontal synchronisation (video / VGA output).
IPL0..2	Interrupt priority level (binary encoded).
IREG	Control signal from the current detector and limiter circuit on the power supply to regulate supply.
ISYS	Interrupt system (2 kHz).
KB..	Keyboard data in.
KBBEEP	Keyboard beep (to audio amplifier).
KBCLR	Keyboard clear.
KBCL1	Keyboard clock.
KBCL2	Keyboard clock.
KBIN..	Keyboard data in - serial data from the keyboard to the CPU.
KBS..	Keyboard Strobe.
KONV	Convert - this signal initiates the conversion of the incoming signal from the ECG Amplifier..
LA	Left Arm.
LCA	Liquid crystal address - enable.
LCDAS	LCD Address Strobe.

Acronyms

LCDKONT	LCD contrast - sets the -18 V voltage level (from which the LCD backlight power is generated) and thus the contrast of the screen.
LCDW	LCD Write.
LD1,2,3,4	Lower LCD data.
LDS	Lower data strobe.
LED (0..3)	Operate signals to the LED indicators on the keyboard.
LEDB	Battery LED.
LEDMAINS	Signal indicating mains connected - to operate LED indicator on the keyboard.
LOE	Lower output enable - control signal for static Ram.
LP	Line synchronisation.
LSRAM	Lower output enable - control signal for static RAM.
LWE	Lower Write Enable - control signal for Static Ram.
M	LCD control signal derived from FLM.
MCLK	Motor Clock - speed control for the printer motor.
MOD	Control signal from the battery charging circuit.
MOFF	Motor off.
MON	Motor On - Printer motor enable signal.
NWTZ	Mains supply.
NMI	Non-maskable interrupt - interrupt for U47 (Schiller gate array) activated by the reset button.
OFF	Off signal from the OFF key to switch off the power supply.
PDS	Control signal derived from FLM (unity waveform 1/2 FLM frequency).
PM	Paper mark signal.
PMARK	Paper mark detection signal.
PMPON	Pacemaker detection pulse.
PMNEG	Pacemaker negative - indicates the trailing edge of a pacemaker pulse.
PMPOS	Pacemaker positive - indicates the leading edge of a pacemaker pulse.
PWM	Pulse Width Modulation
QTRRG	QRS trigger - output signal.
RA	Right Arm.
RAS	Row address strobe.
RES	Reset.

Acronyms

RESLCD/	Resets / darkens the LCD.
RES/P	Error reset signal to inactivate the LCD.
RTS	Ready to send - ougoing serial data, handshake with CTS.
RXD	Receive data - incoming serial data.
R / W	Read / Write
SC(0..8)	System control bus - CPU control signals.
SCINV	Screen inversion.
SI	Serial in.
SO	Serial output from the CPU to the ECG amplifier via opto isolators.
SP..	Spirometry control and data signals.
SRAM	Static RAM memory.
STRB1/2	Timing signals for printer control.
SYSEN	System enable - active when the program pack is inserted. The CPU will not work if this signal is not active.
TGATE	Gate pulse for programmable timer. This signal sets the TPDUR signal.
TM	Thermal printer temperature - dc voltage from the print head, pulse width modulation of signal TPTH.
TPC	Thermal printer clock. This is not a continuous clock signal but is active when loading a line of printer data (into shift registers).
TPCLK	Thermal printer clock.
TPD	Thermal printer data - serial data for the printer.
TPDUR	Thermal printer duration - duration of the strobe pulse dependant on the ambient temperature of the print head and the resistance of the print head.
TPCSEL	Thermal printer controller select - control of thermal printer FIFO (input memory buffer).
TPL	Thermal printer latch - print strobe control and data latch signal.
TPRES	Thermal printer reset - FIFO reset for thermal printer controller.
TPS 0 & 1	Thermal Printer Strobe - master timing strobe enable signal.
TPTH	Thermal Printer temperature - dc voltage from the print head to ADC, approximately 3.7V at room temperature.
TS	Temperature sense (from battery).
TXD	Outgoing serial data.

Acronyms

µPOFF	Off control signal. Logic 1 keeps the unit switched on, Logic 0 switches the unit off . Note that the unit is initially switched on directly from the ON key on the keyboard.
U1,2,3,4	Upper LCD data.
+UB	Battery voltage.
UCAS	Upper column address strobe (for dynamic RAM).
UD1, UD2	Upper data strobe - used for generating UOE and UWE.
UDS	Upper Data Strobe - used on the SCHILLER gate array.
UOE, USRAM	Upper output enable - for static RAM.
+UP	Voltage rectified from the mains input and regulated to approximately + 15 V.
UWE	Upper Write Enable - for static RAM.
+U	Unregulated dc supply from mains (approximately 30 V).
+UBU	Back-up voltage for the real time clock and static RAM.
+UD	Unswitched regulated dc voltage used as power source for the switched supply +US. The voltage is 13.5V when mains is connected, or battery voltage when mains is not connected. When mains is connected, this supply charges the battery.
-ULCD	Contrast voltage to LCD.
+US	Switched dc voltage of 13.5V when mains is connected or battery voltage when working from the battery. Input voltage for all PSUs on the power supply board.
VCC	+5 V.
VMA	Valid memory address.
VPA	Valid peripheral address.
VSYNC	Vertical synchronisation - (video / VGA output).
WP0 and WP1	ECG In - the serial multiplexed ECG serial data to the CPU sent over the optical interface, from the ECG Amplifier.
XD0..XD3	Pixel information.
XSCL	Shift clock for XDn.
YD	Frame synchronisation.
YDIS/	LCD off.
ZEROSET	Baseline reset (on the ECG amplifier) from the processor.

Service Handbook Document History

AT-60

Service Handbook Issue 2 December 1998 Art. No. 2.540 003 Delivery date: 08.01.99

							Receipt Acknowledged						
Unit	**Detail**	**Article Number**	**Drawing date**	**Description**	**HW**	**Delivery date**	**DE**	**AU**	**IT**	**FR**	**US**	**CAN**	**CHD**
AT-60	MK13-8	2456Aa	05.07.96	Calibrations Switch		08.01.99							
AT-60	MK7-1	2180Ha 2180Ka	16.02.93 19.11.93	Processor Board		08.01.99							
AT-60	MK7-11	2197Ca	07.10.93	Program Pack		08.01.99							
AT-60	MK7-12	2198Ba	07.10.93	Bus/Interface		08.01.99							
AT-60	MK7-13	2199Aa	07.10.93	µP-Expansion Board, ersetzt MK7-12 wenn Floppy-Option installiert ist.		08.01.99							
AT-60	MK7-131	2215Aa	26.08.96	Floppy - Connector		08.01.99							
AT-60	MK7-20	2223Aa 2223Ba 2223Ca 2223Cb 2223CC 2223CD 2223DA	29.09.93 09.02.94 25.04.94 19.12.94 28.01.98 23.02.98 25.06.98	ECG Interface		08.01.99							
AT-60	MK7-48	2227Aa	20.02.96	DC Filterprint		08.01.99							
AT-60	MK7-49	2228aA	29.11.95	Trafo Filterprint		08.01.99							
AT-60	MK7-51	2221Aa	11.10.93	Externe Trimmer		08.01.99							
AT-60	MK7-5E	2202Ca 2202Ea 2202EB	07.10.93 10.04.94 04.06.97	TP/Keyboard Interface wie 2191EB mit spezieller Bestueckung		08.01.99							
AT-60	MK7-6	2192Ba 2192Ca 2192Cb 2192Cc 2192Cd 2192CE 2192CF	11.10.93 20.04.95 20.04.95 20.04.95 21.06.95 09.10.96 03.06.97	Power Supply		08.01.99							

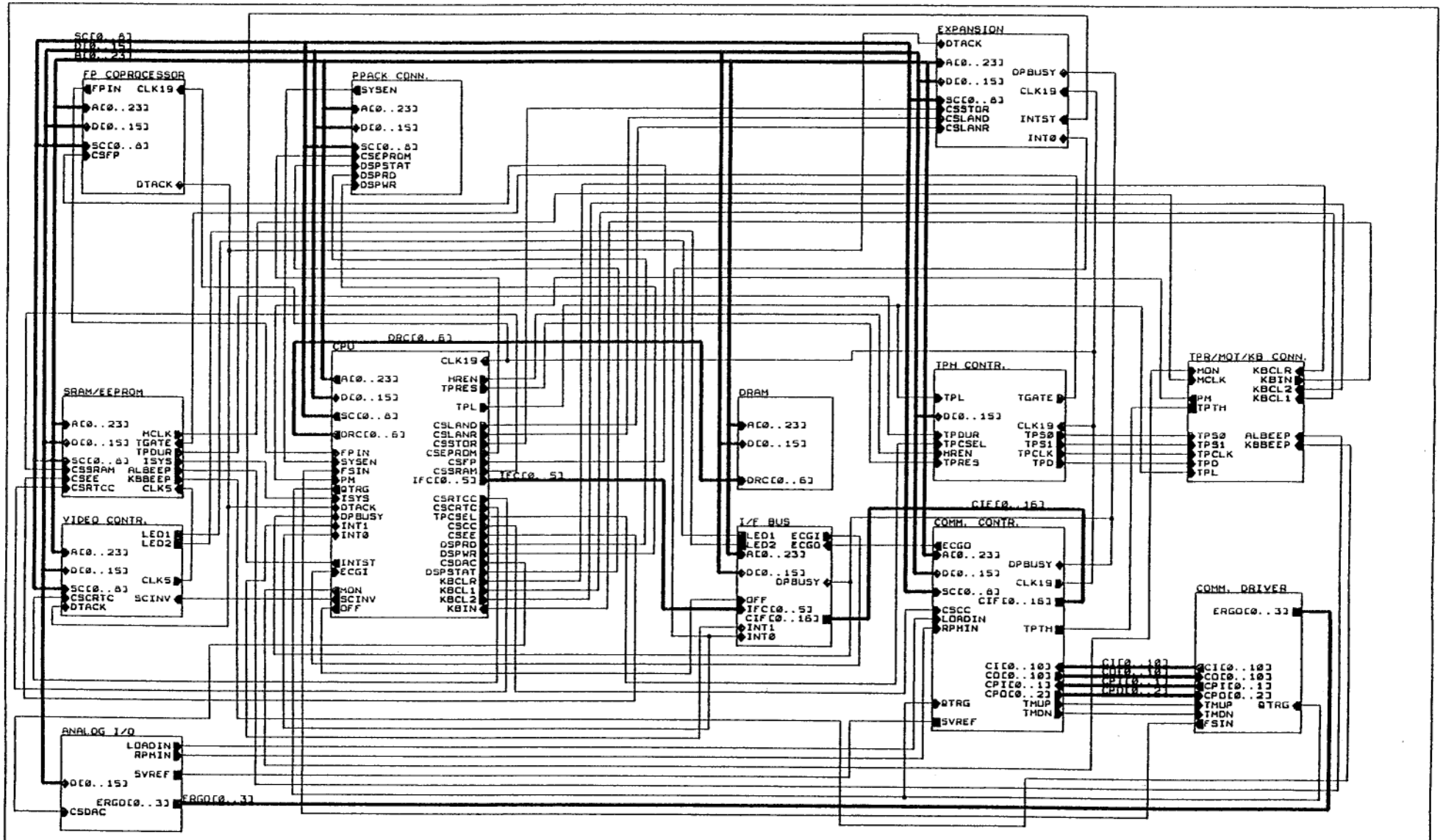
AT-60 Circuit Diagrams and Board Layouts

Microprocessor Board MK 7-1

& Program Pack MK 7-11

MK 7-7, MK 7-48, 49, 51

MK 7-91, MK 7-131



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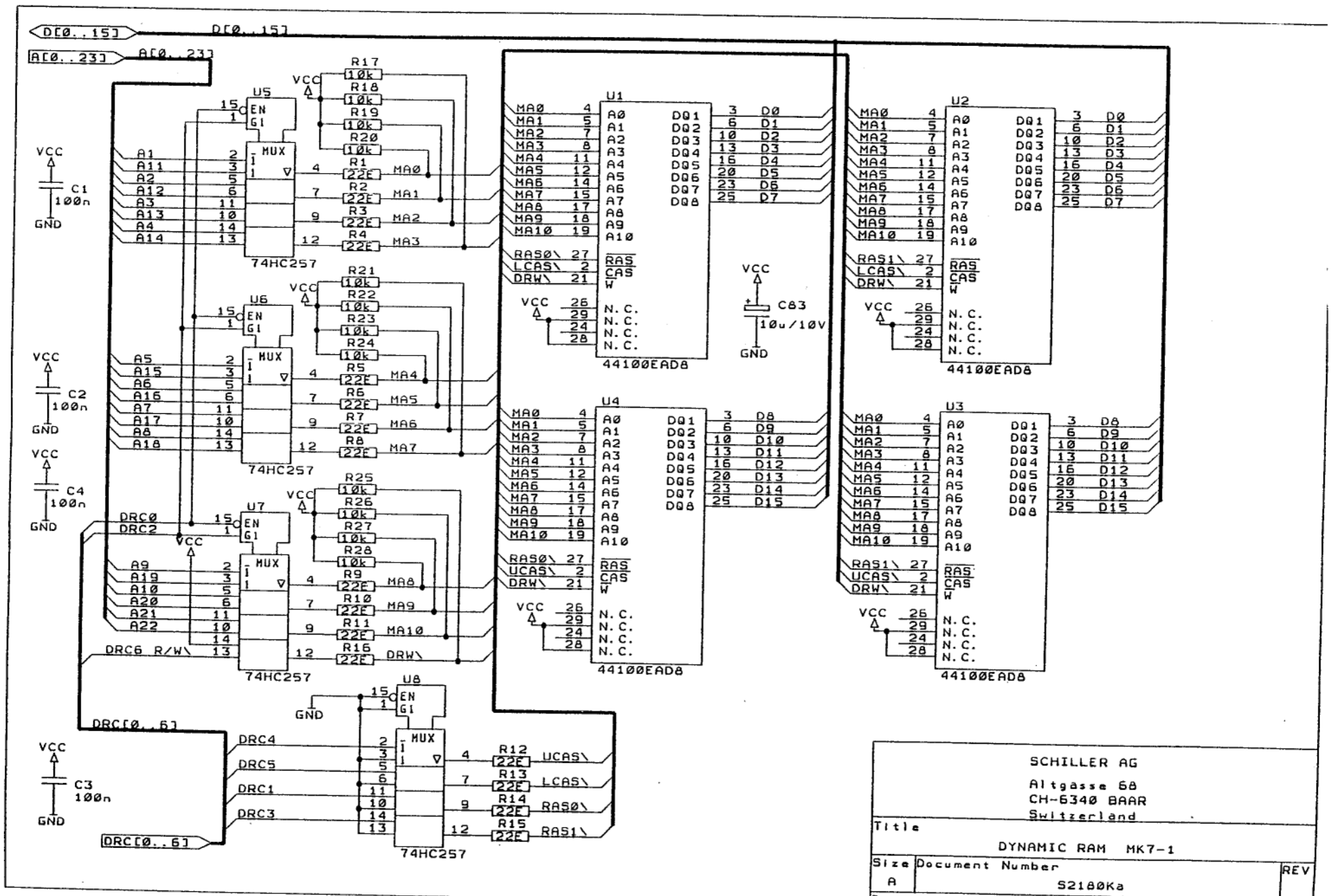
Title: PROCESSOR BOARD CS-100 (MK7-1)

Size	Document Number	REV
B	S2100Ka	

Date: November 19, 1993 Sheet 1 of 14


D[0..15]
A[0..23]
U5
U6
U7
U8
74HC257
U1
U2
U3
U4
44100EAD8
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
10k
22E
C1
C2
C3
C4
100n
C83
10u/10V
VCC
GND
MA0
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
RAS0\
RAS1\
LCAS\
UCAS\
DRW\
DRC0
DRC2
DRC6 R/W\
DRC4
DRC5
DRC1
DRC3
DRC[0..6]
SCHILLER AG
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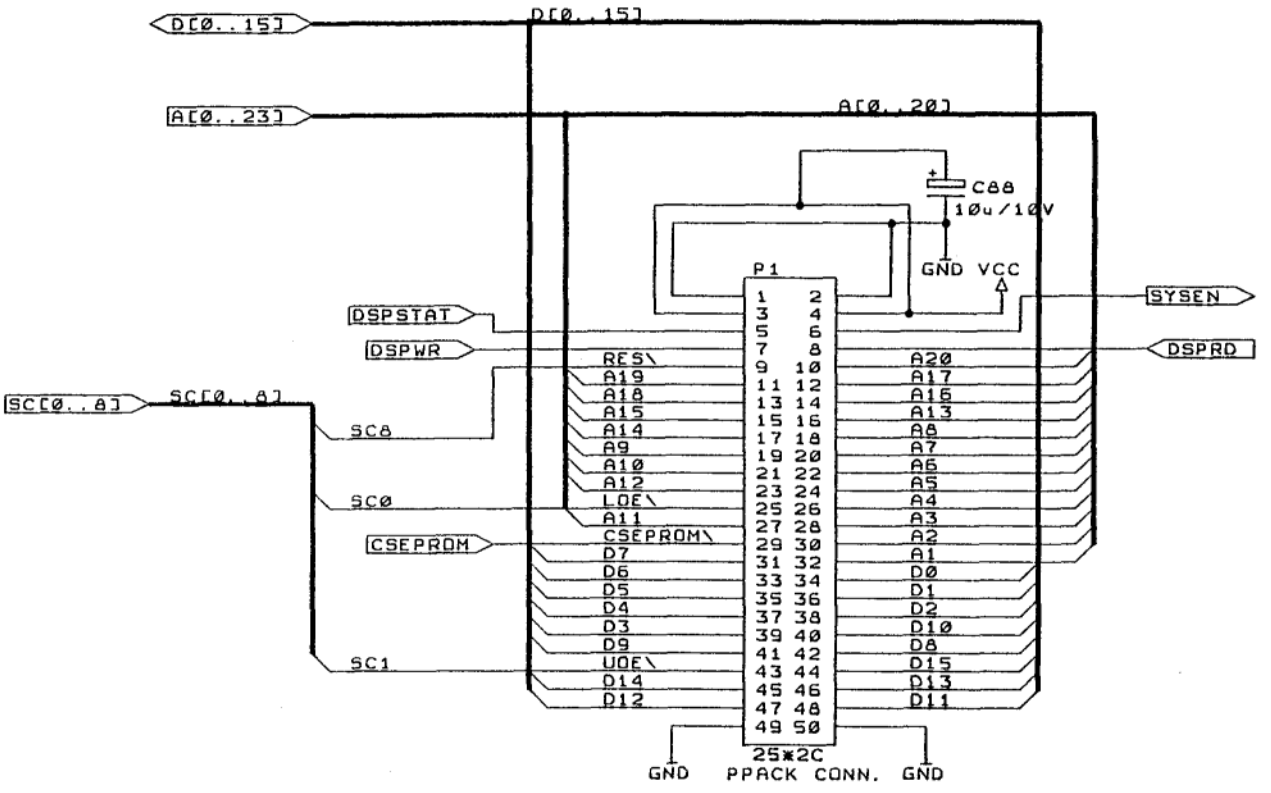
Switzerland
Title
DYNAMIC RAM MK7-1
Size A
Document Number
S2180Ka
REV
Date: November 19, 1993
Sheet 2 of 14



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
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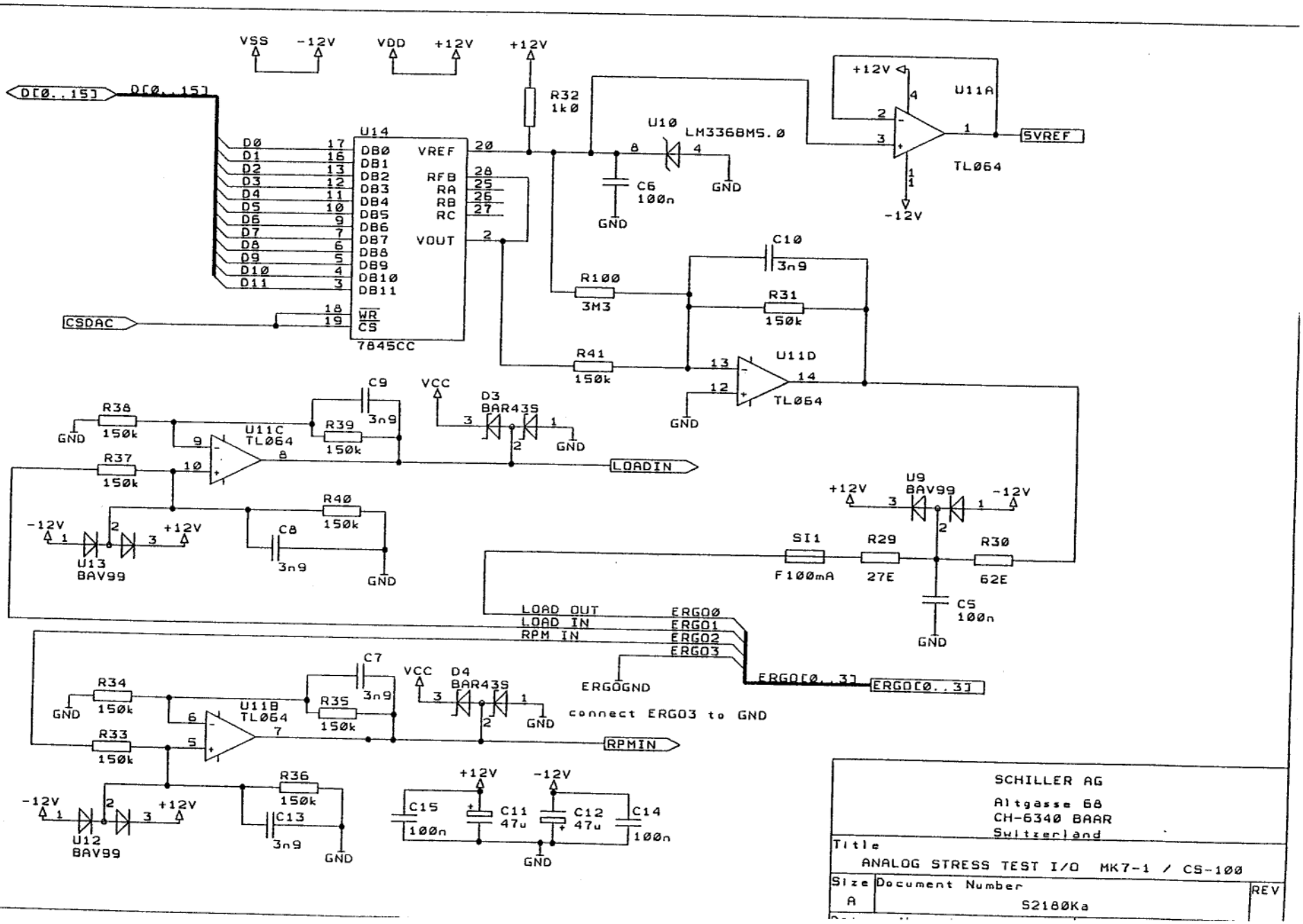
Size A	Document Number S2180Ka	REV
Date: November 19, 1993	Sheet 3 of 14	


VSS -12V
VDD +12V
+12V
D[0..15]
R32
1k0
U14
U10
LM336BM5.0
U11A
TL064
SVREF
C6
100n
GND
-12V
C10
3n9
R100
3M3
R31
150k
CSDAC
WR
CS
7845CC
R41
150k
U11D
TL064
C9
3n9
VCC
D3
BAR43S
R38
150k
U11C
TL064
R39
150k
R37
150k
LOADIN
U9
BAV99
SI1
F100mA
R29
27E
R30
62E
R40
150k
C8
3n9
U13
BAV99
C5
100n
LOAD OUT
LOAD IN
RPM IN
ERGO0
ERGO1
ERGO2
ERGO3
ERGOGND
ERGO[0..3]
C7
3n9
D4
BAR43S
R34
150k
U11B
TL064
R35
150k
R33
150k
RPMIN
connect ERGO3 to GND
R36
150k
C13
3n9
U12
BAV99
C15
100n
C11
47u
C12
47u
C14
100n
SCHILLER AG
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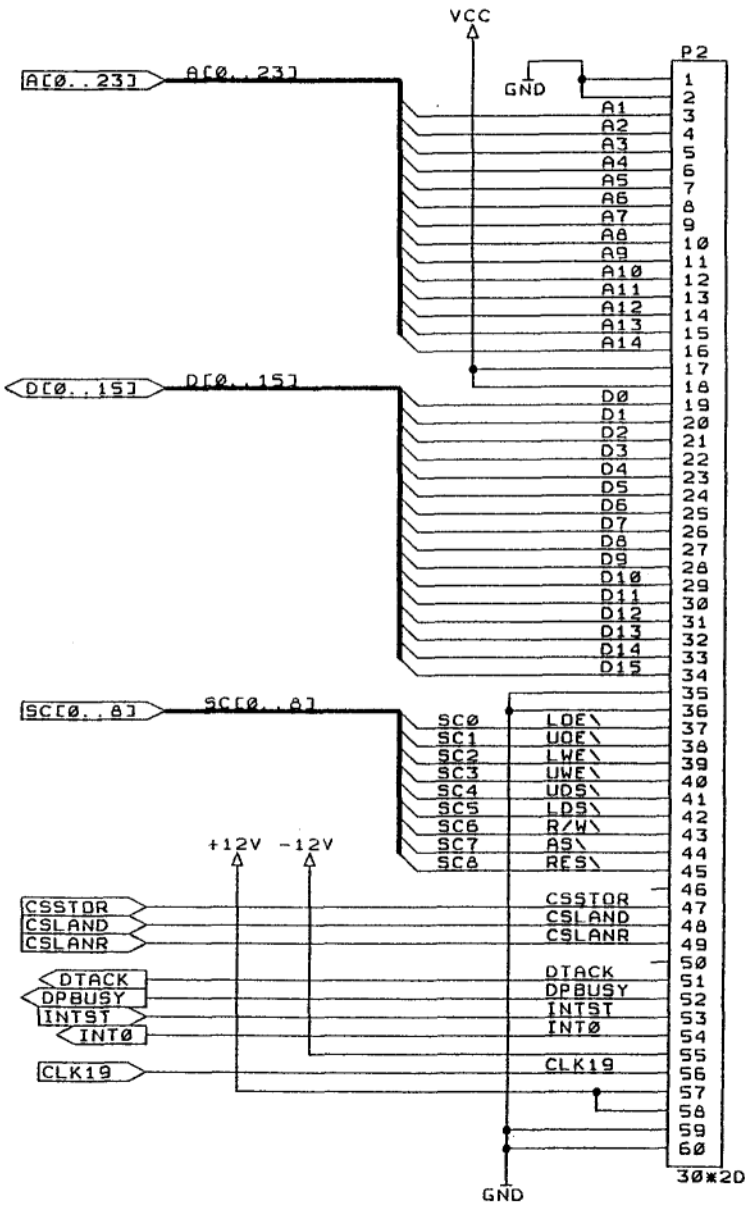
Switzerland
Title
ANALOG STRESS TEST I/O MK7-1 / CS-100
Size
A
Document Number
S2180Ka
REV



REV B: pins 57 und 58 P2 connected

SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
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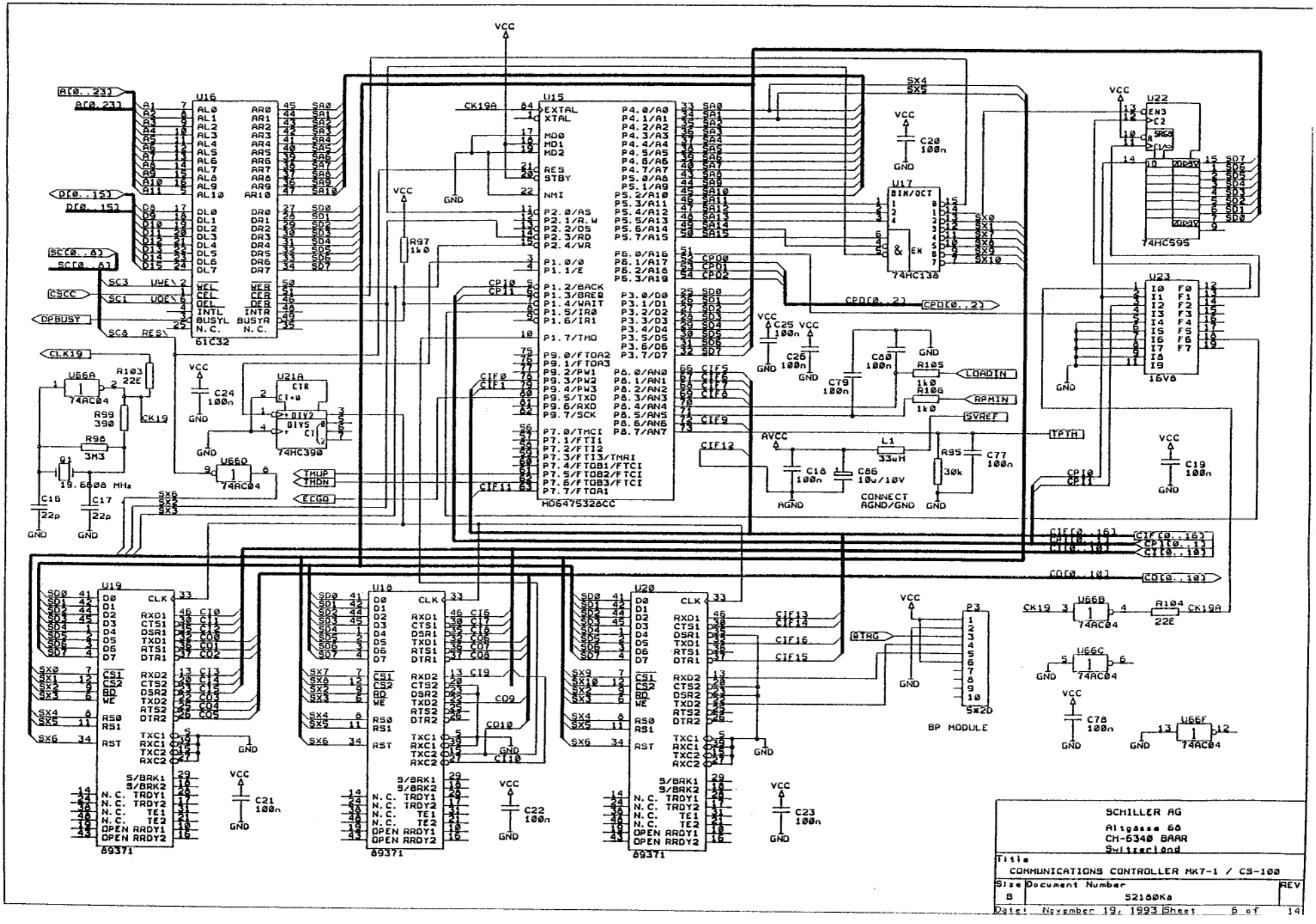
Size A	Document Number S2180Ka	REV
Date: November 19, 1993	Sheet 5 of 14	


SCHILLER AG
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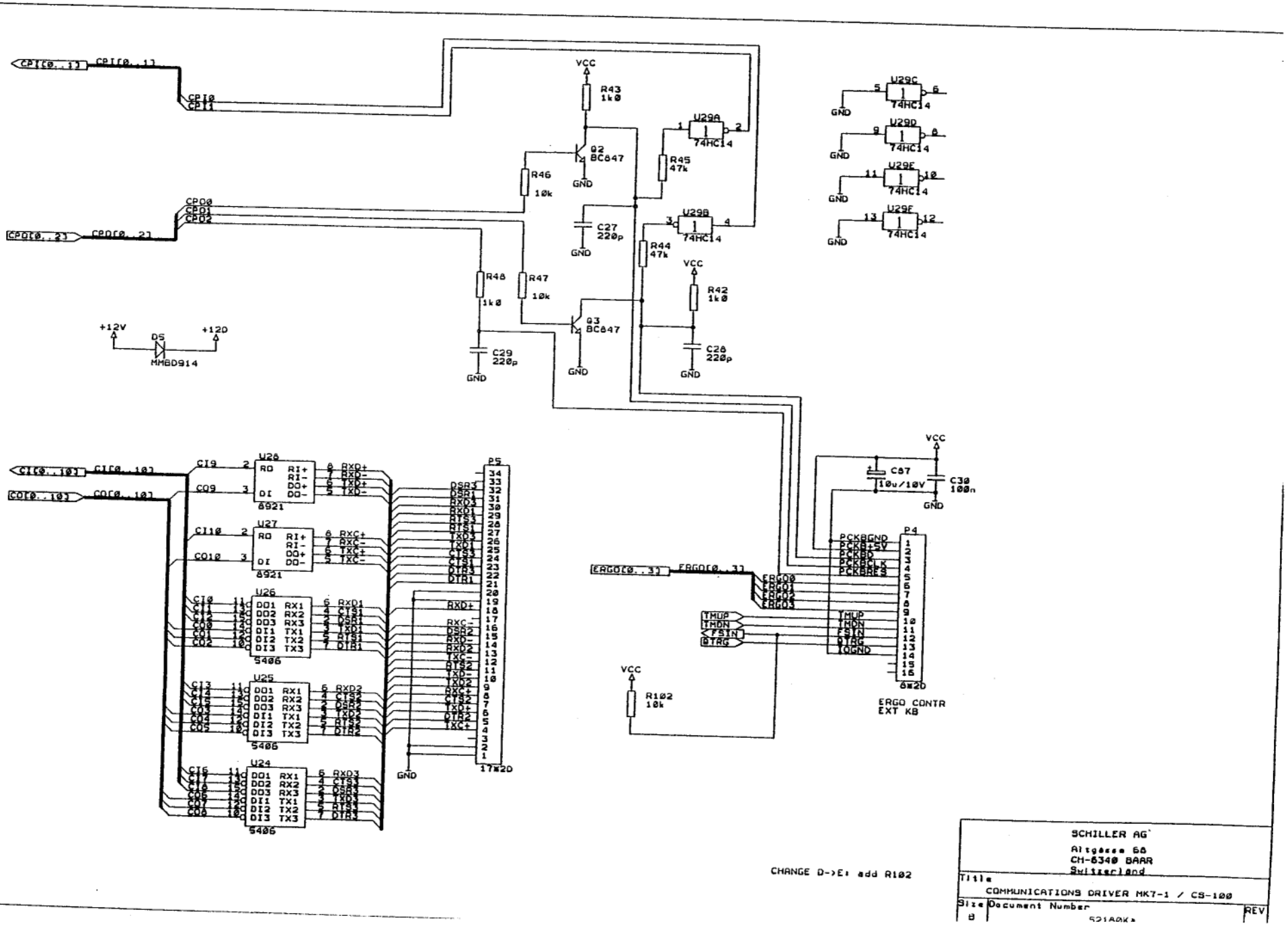
COMMUNICATIONS CONTROLLER MK7-1 / CS-100
Size B
Document Number
52180Ka
REV
Date: November 19, 1993 Sheet 5 of 14
VCC
GND
U15
HD6475328CC
U16
61C32
U17
74HC138
74HC595
U18
U19
U20
89371
U21A
74HC390
U22
U23
16V8
U66A
U66B
U66C
U66D
U66F
74AC04
P3
5x2D
BP MODULE
CONNECT AGND/GND
AGND
AVCC
CK19A
CK19
LOADIN
RPMIN
SVREF
TPYH
QTRG
R97 1k0
R99 390
R98 3M3
R103 22E
R104 22E
R105 1k0
R106 1k0
R95 30k
C15 22p
C16 22p
C17 22p
C18 100n
C19 100n
C20 100n
C21 100n
C22 100n
C23 100n
C24 100n
C25 100n
C26 100n
C77 100n
C78 100n
C79 100n
C80 100n
C86 10u/10V
L1 33uH
Q1 19.6608 MHz


CPI[0..1]
CPI0
CPI1
CPO[0..2]
CPO0
CPO1
CPO2
VCC
R43 1k0
R46 10k
Q2 BC847
GND
R45 47k
U29A 74HC14
C27 220p
R44 47k
U29B 74HC14
R48 1k0
R47 10k
Q3 BC847
C29 220p
R42 1k0
C28 220p
U29C 74HC14
U29D 74HC14
U29E 74HC14
U29F 74HC14
+12V
D5
+12D
MMBD914
CI[0..10]
CO[0..10]
U26
U27
U25
U24
8921
5406
P5
17W2D
RXD+
RXC-
GND
ERGO[0..3]
ERGO[0..3]
TMUP
TMDN
FSIN
BTRG
P4
8W2D
ERGO CONTR
EXT KB
C87 10u/10V
C30 100n
R102 10k
CHANGE D->E: add R102
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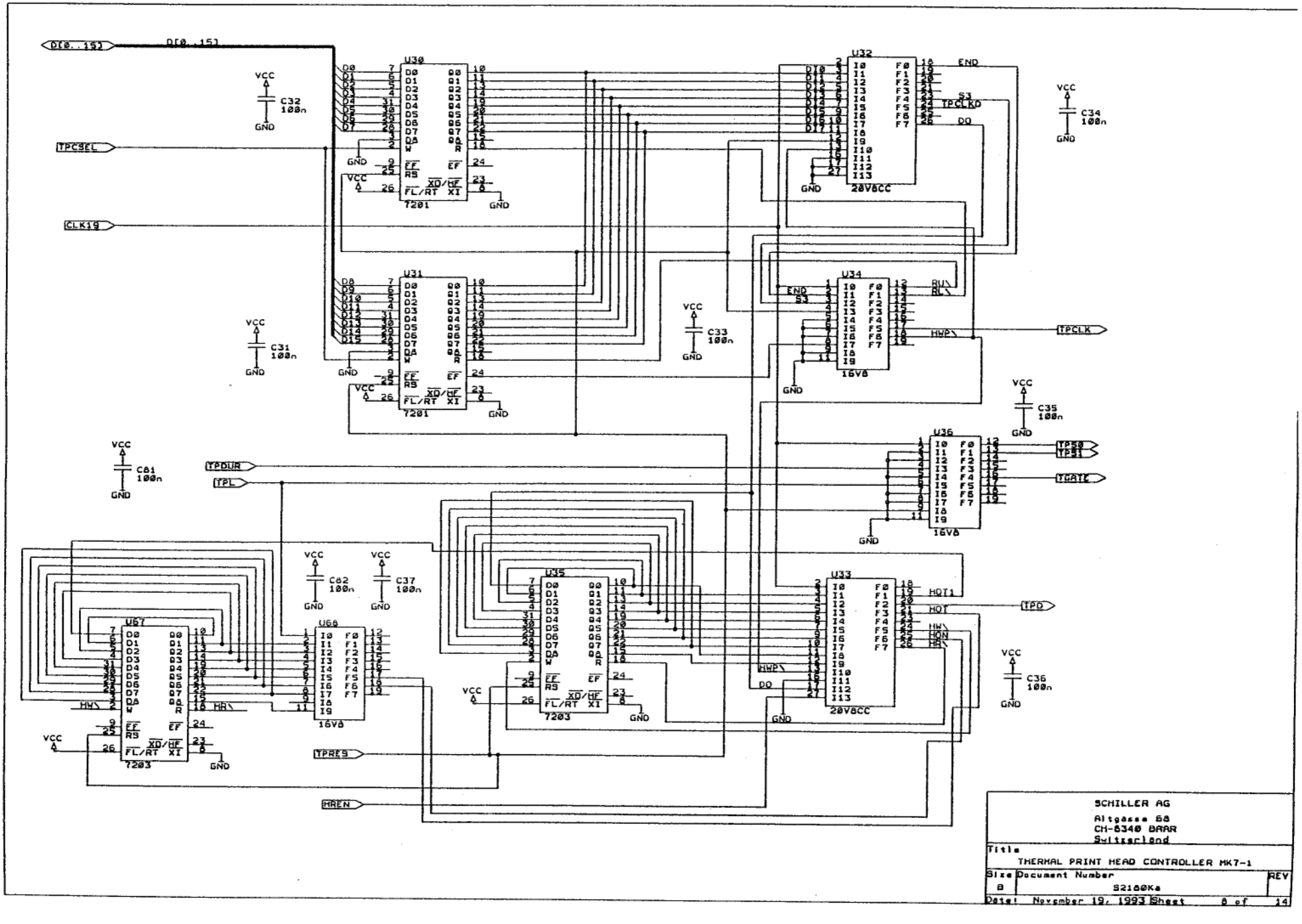
Title
COMMUNICATIONS DRIVER MK7-1 / CS-100
Size B
Document Number
REV



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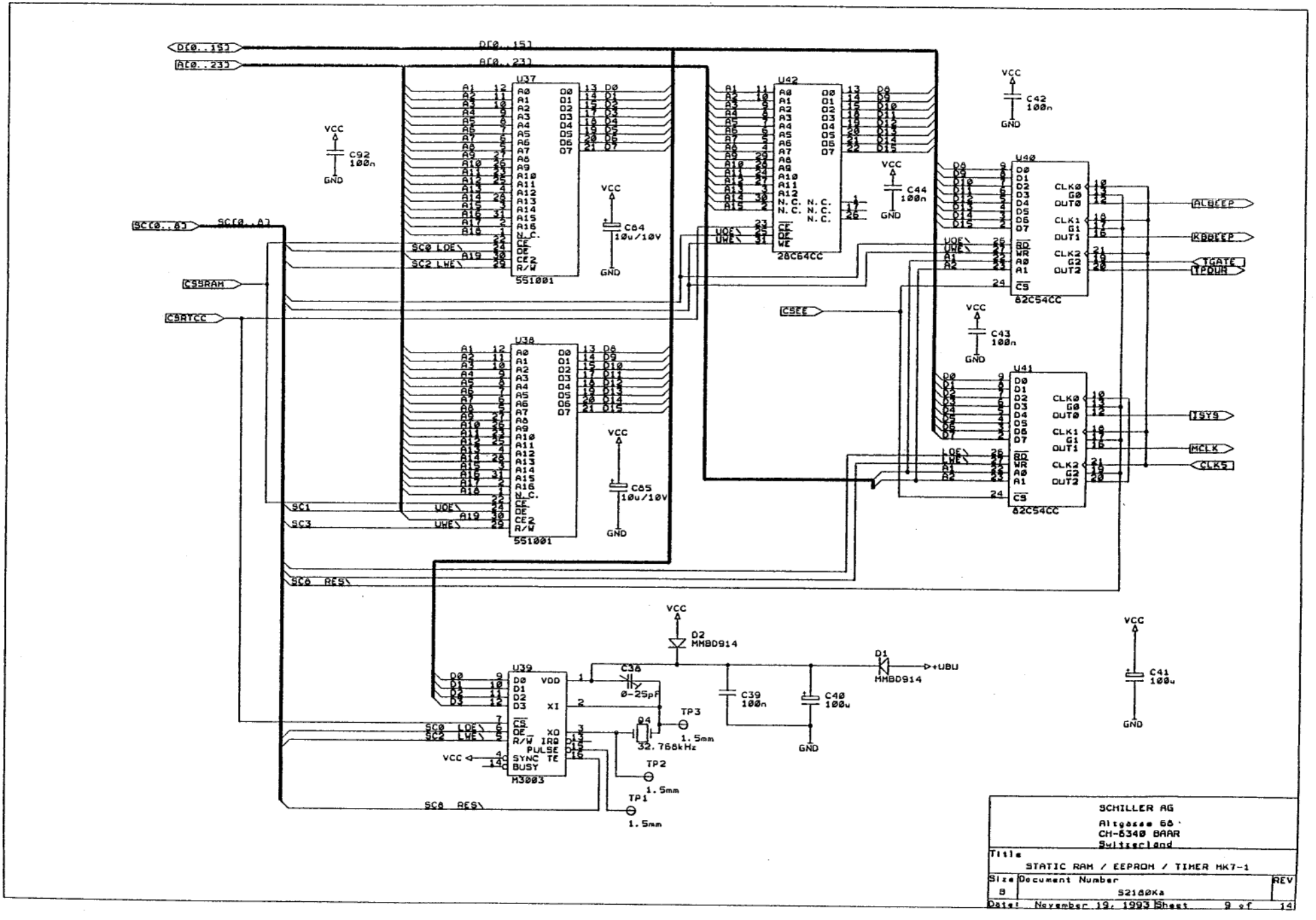
Title
THERMAL PRINT HEAD CONTROLLER MK7-1

Size	Document Number	REV
B	S2180Ka	

Date: November 19, 1993 Sheet 8 of 14



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland	
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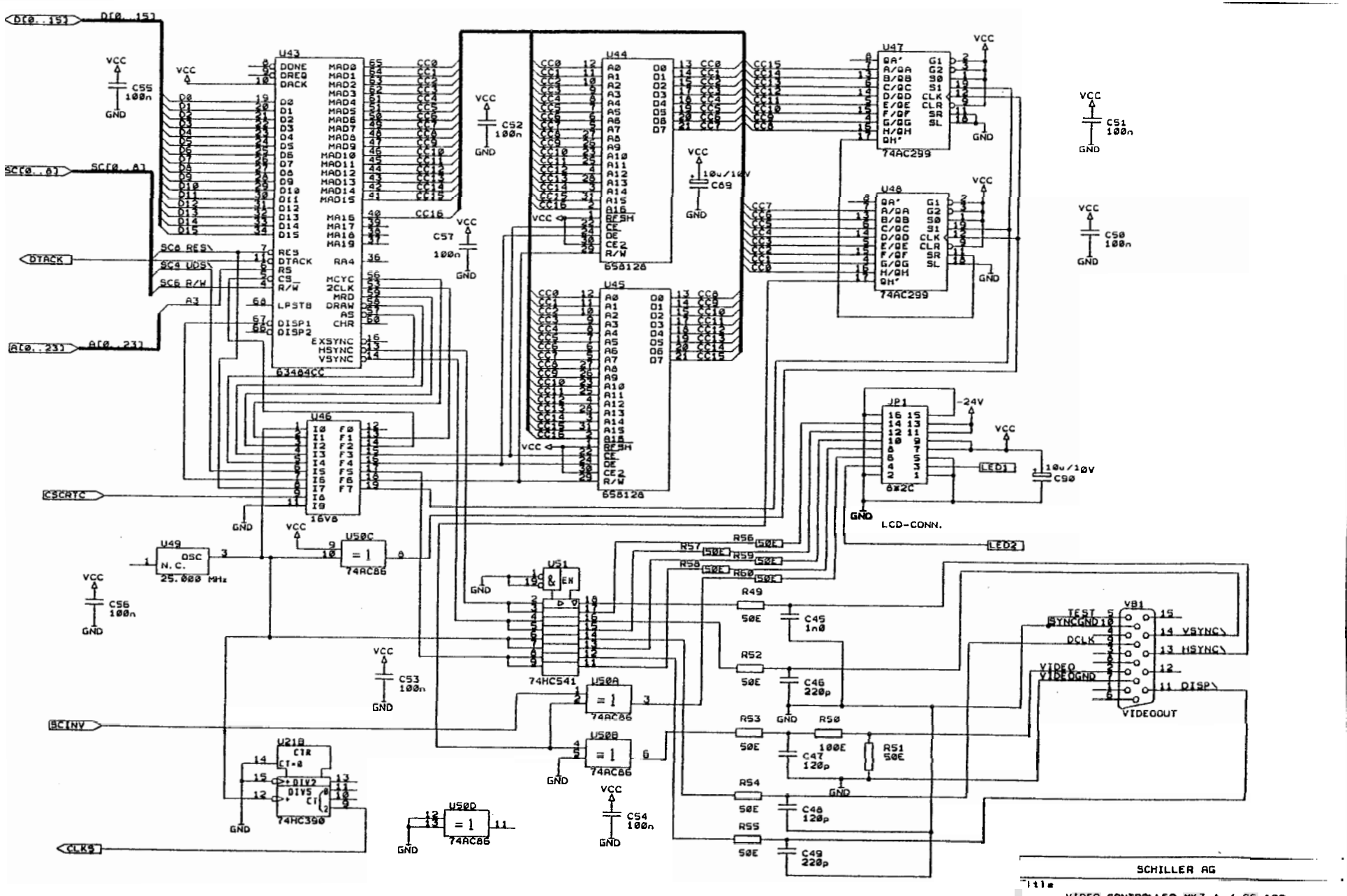
Size: B	Document Number: 52160Ka — REV
Date: November 19, 1993	Sheet 9 of 14


SCHILLER AG
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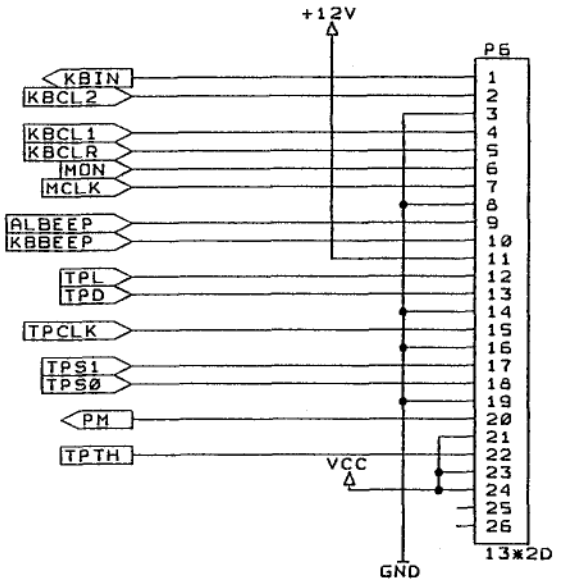
Size B
Document Number S2100Ka
REV
Date: November 19, 1993 Sheet 10 of 14
U43
U44
U45
U46
U47
U48
U49
U50A
U50B
U50C
U50D
U51
U21B
JP1
VB1
74AC299
74AC86
74HC541
74HC390
LCD-CONN.
VIDEOOUT
25.000 MHz
-24V
VCC
GND



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
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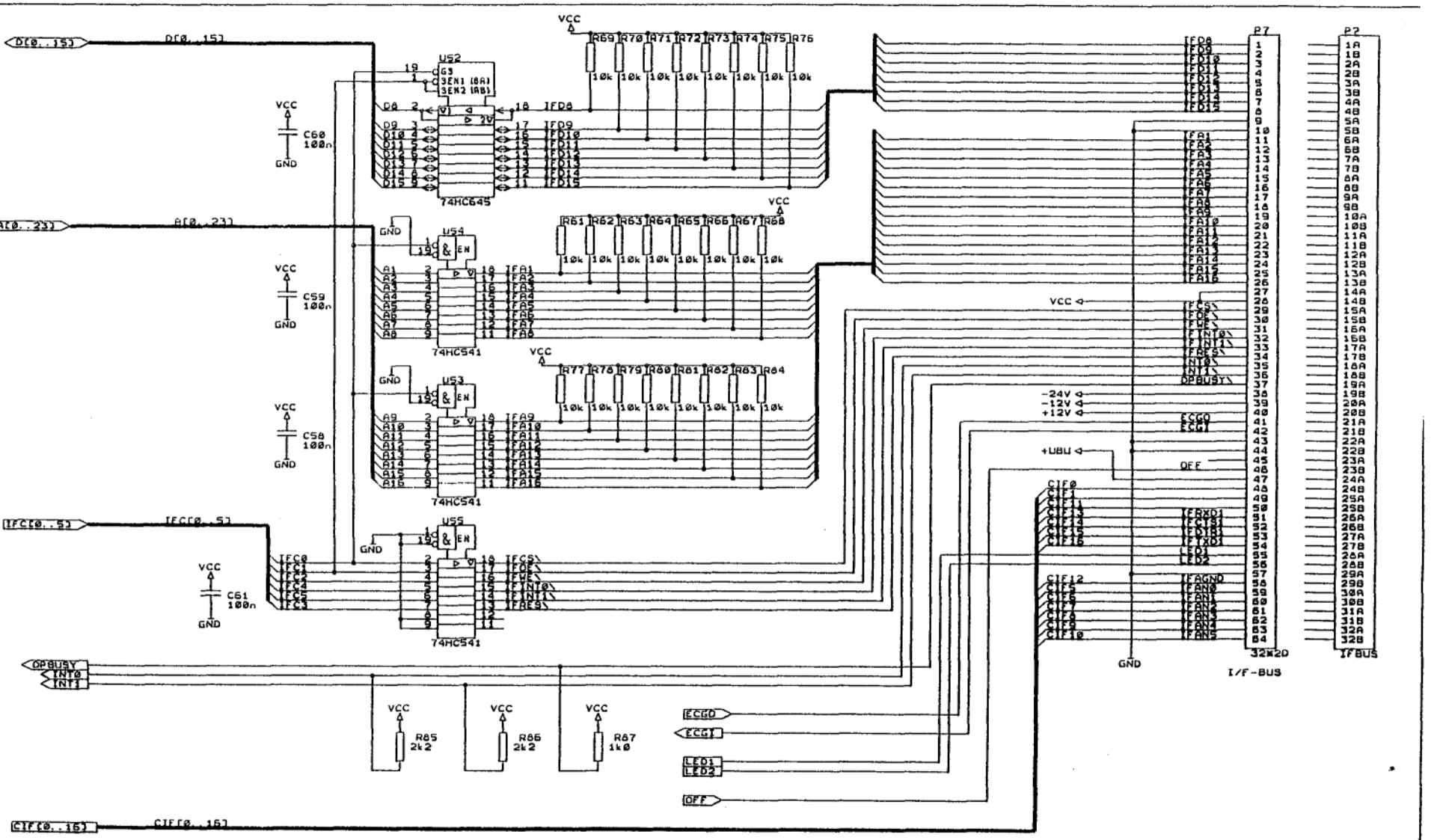
Size A	Document Number 52180Ka	REV
Date: November 19, 1993	Sheet 11 of 14	



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
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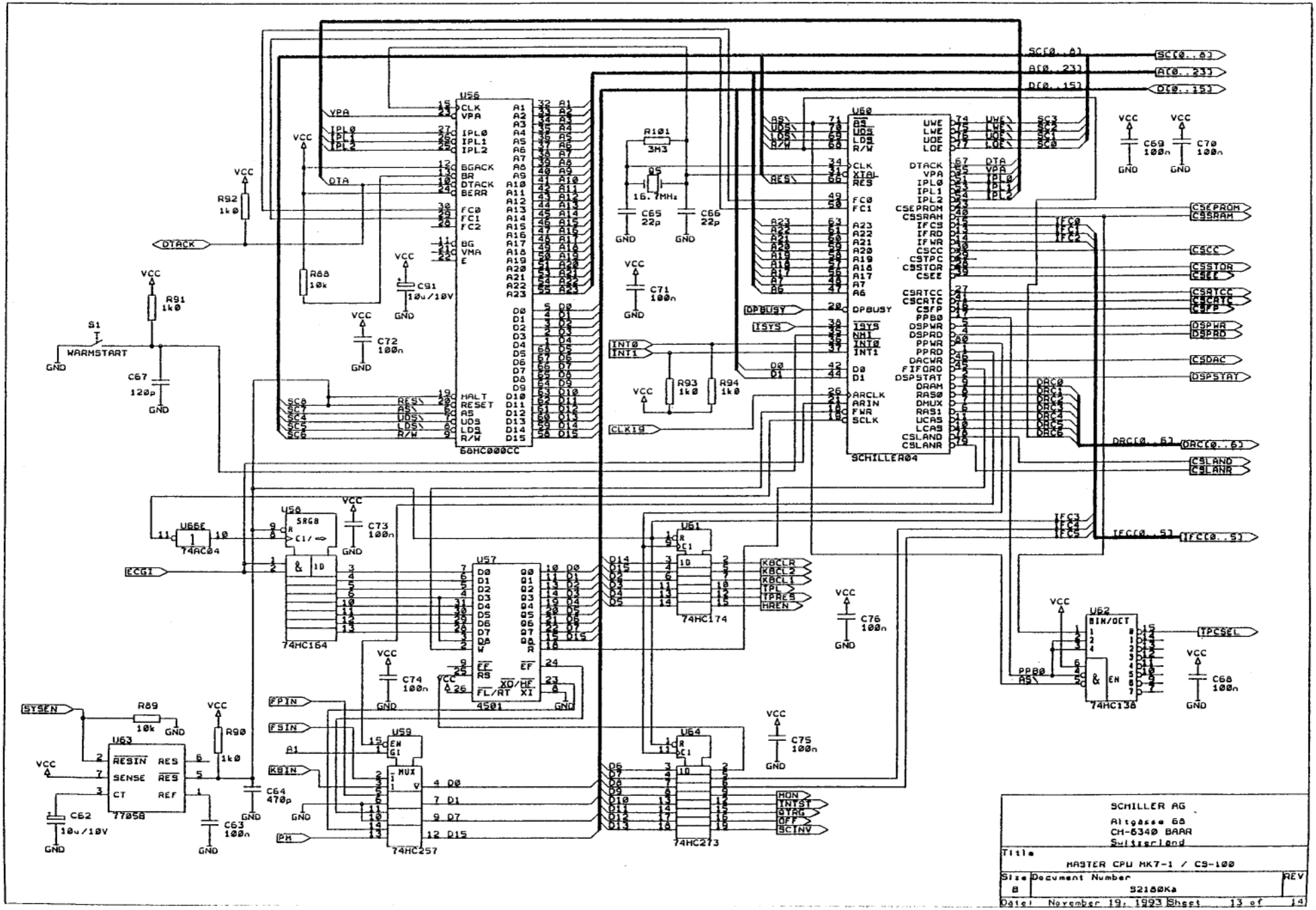
Date: November 19, 1993	Sheet 12 of 14	


SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland
Title
MASTER CPU MK7-1 / CS-100
Size B
Document Number 92180Ka
REV
Date: November 19, 1993 Sheet 13 of 14
U56
68HC000CC
U60
SCHILLER04
U50
74HC164
U57
4501
U61
74HC174
U64
74HC273
U59
74HC257
U62
74HC138
U63
77058
U66E
74AC04
R101 3M3
Q5 16.7MHz
C65 22p
C66 22p
R91 1k0
R92 1k0
R88 10k
R89 10k
R90 1k0
C62 10u/10V
C63 100n
C64 470p
C67 120p
C68 100n
C69 100n
C70 100n
C71 100n
C72 100n
C73 100n
C74 100n
C75 100n
C76 100n
C91 10u/10V
R93 1k0
R94 1k0
S1 WARMSTART
VCC
GND
DTACK
VPA
ECGI
SYSEN
FPIN
FSIN
KBIN
PM
HON
INTST
QTRG
OFF
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TPCSEL
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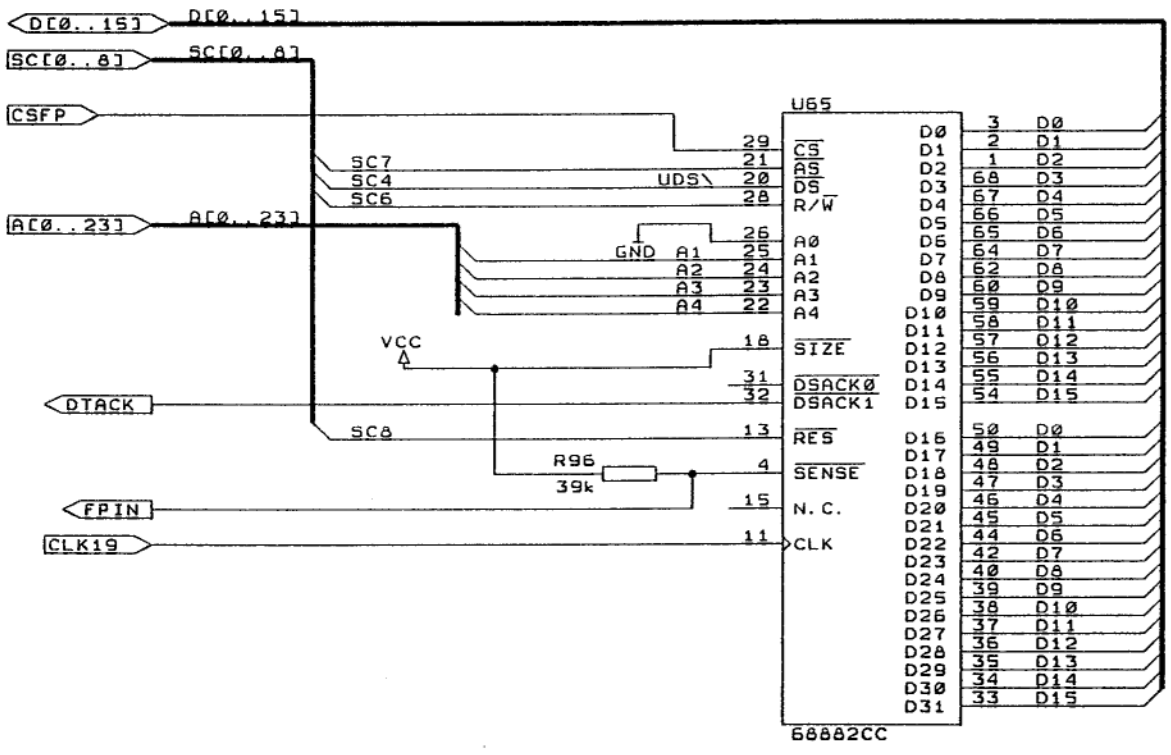
A[0..23]
D[0..15]
DAC[0..6]
IFC[0..5]



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Title
FLOATING POINT COPROCESSOR MK7-1 / CS-100

Size	Document Number	REV
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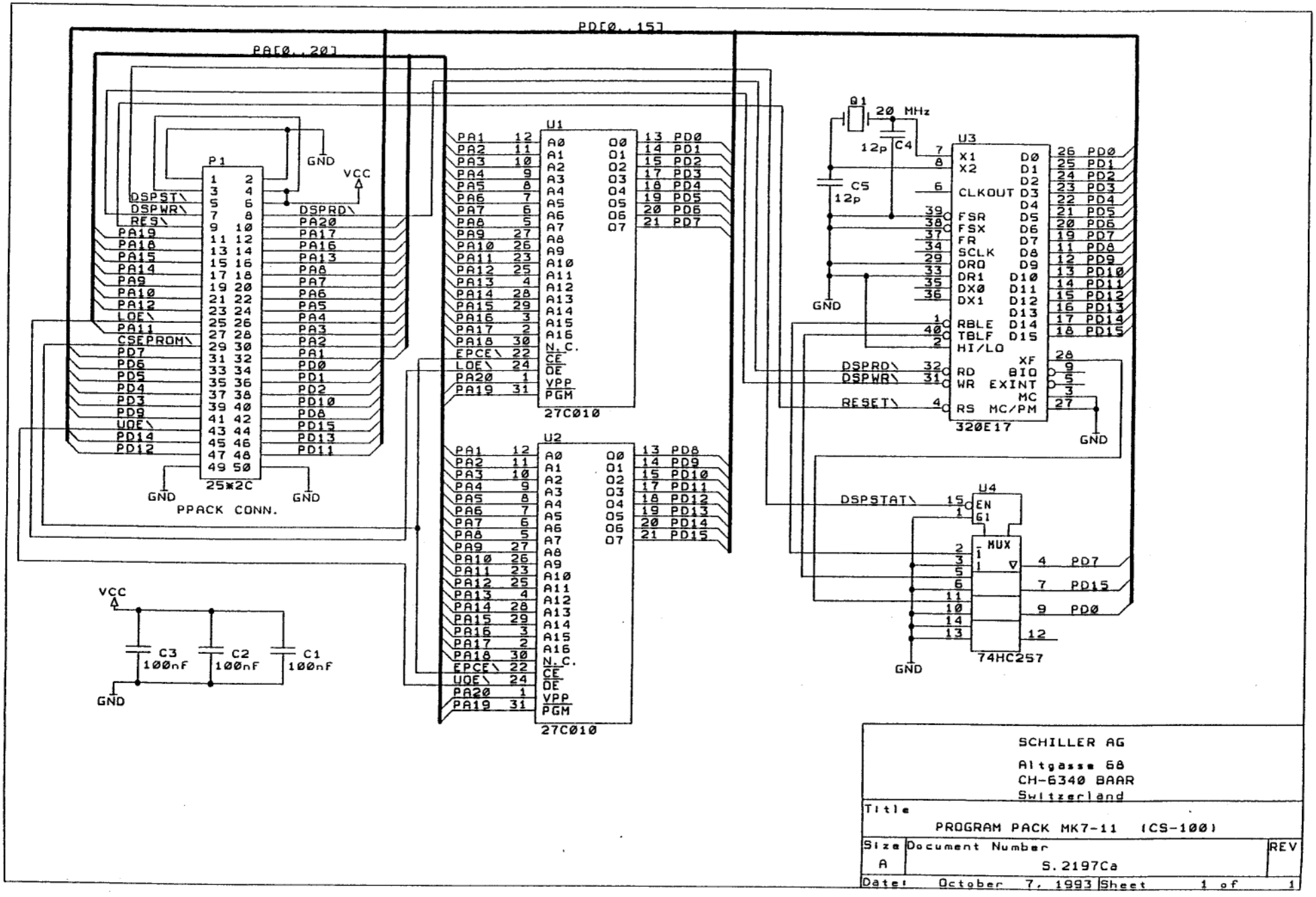
Date: November 19, 1993 Sheet 14 of 14



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland	
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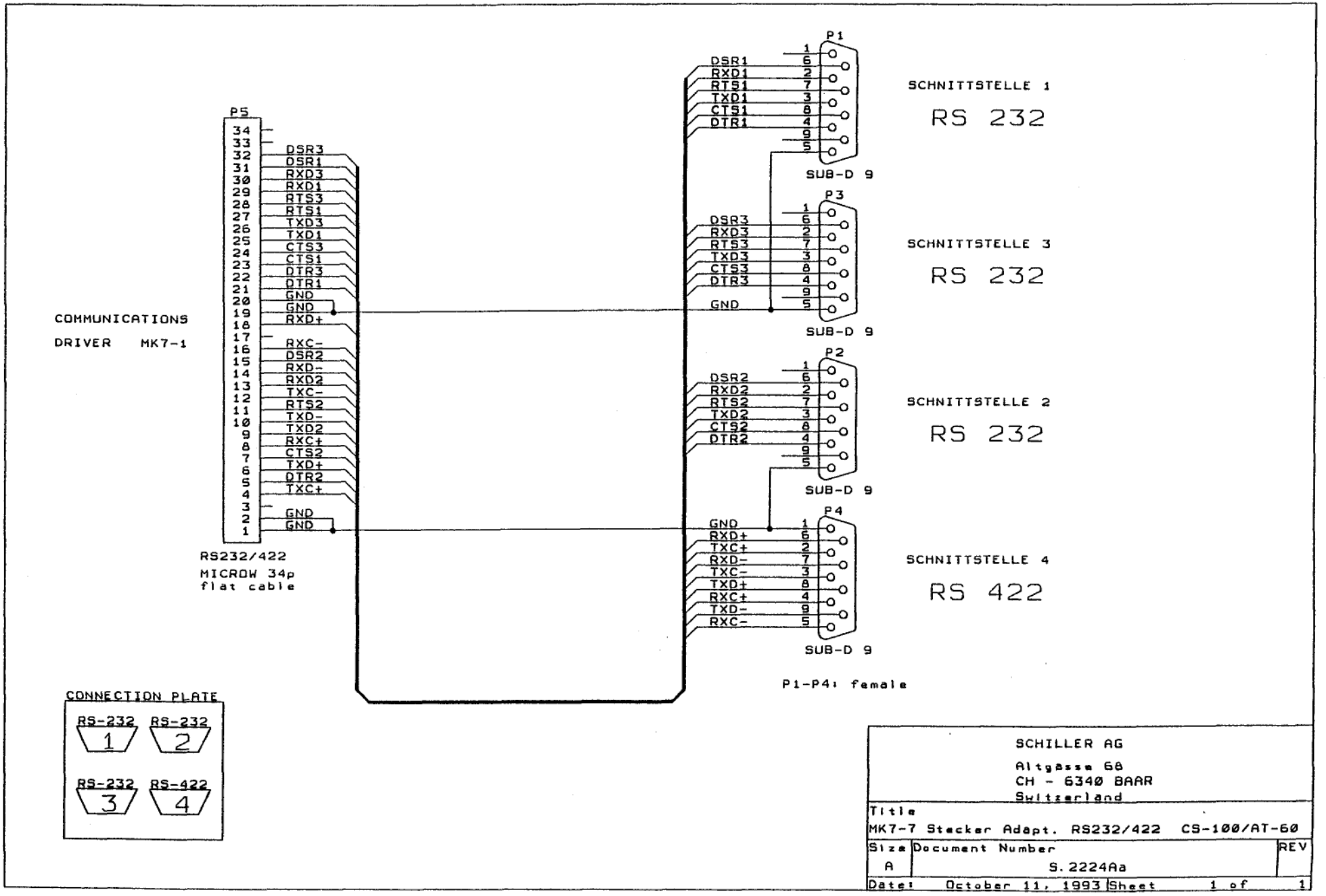
Size: A	Document Number: S.2197Ca — REV:
Date: October 7, 1993	Sheet 1 of 1



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Title
MK7-7 Stecker Adapt. RS232/422 CS-100/AT-60

Size	Document Number	REV
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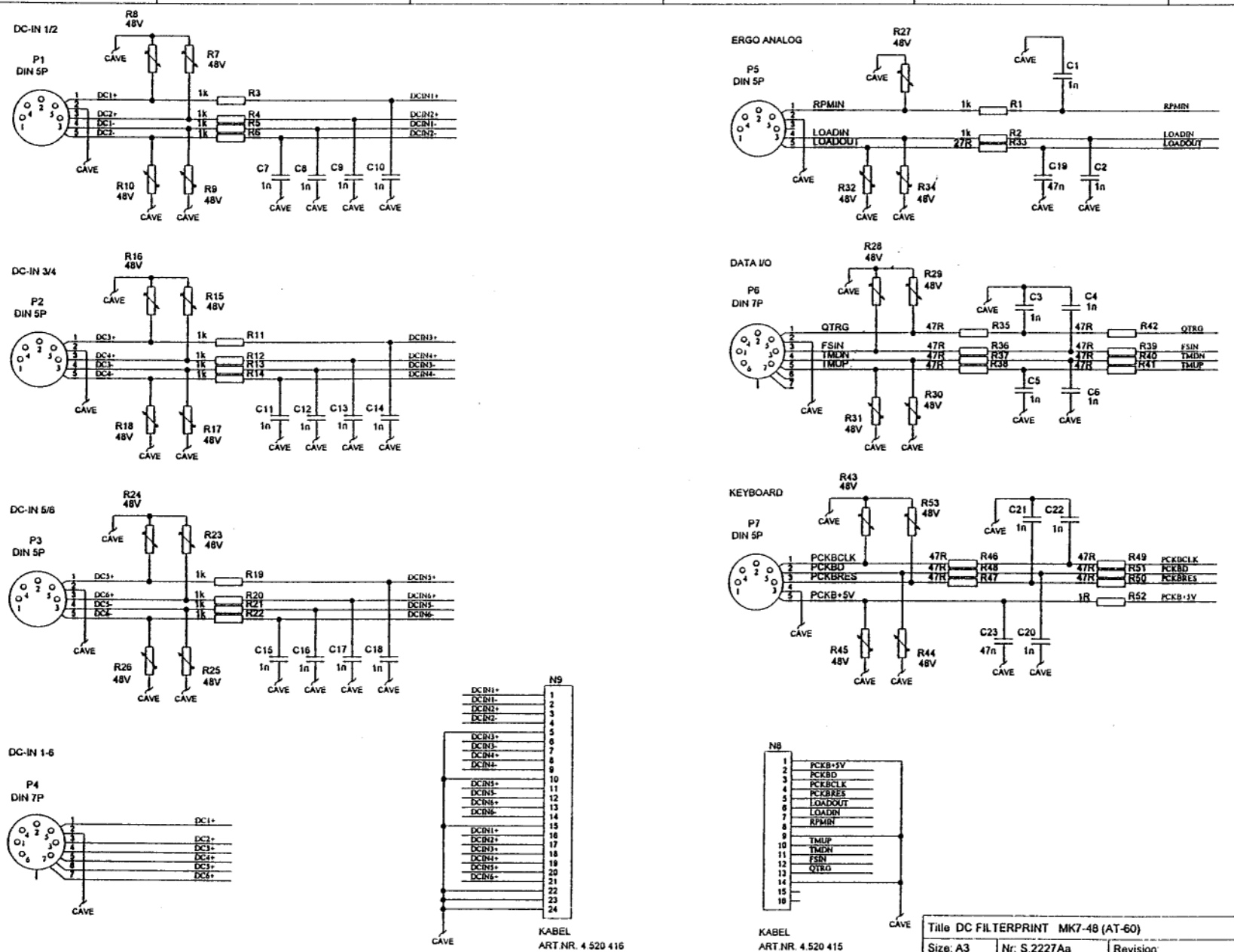
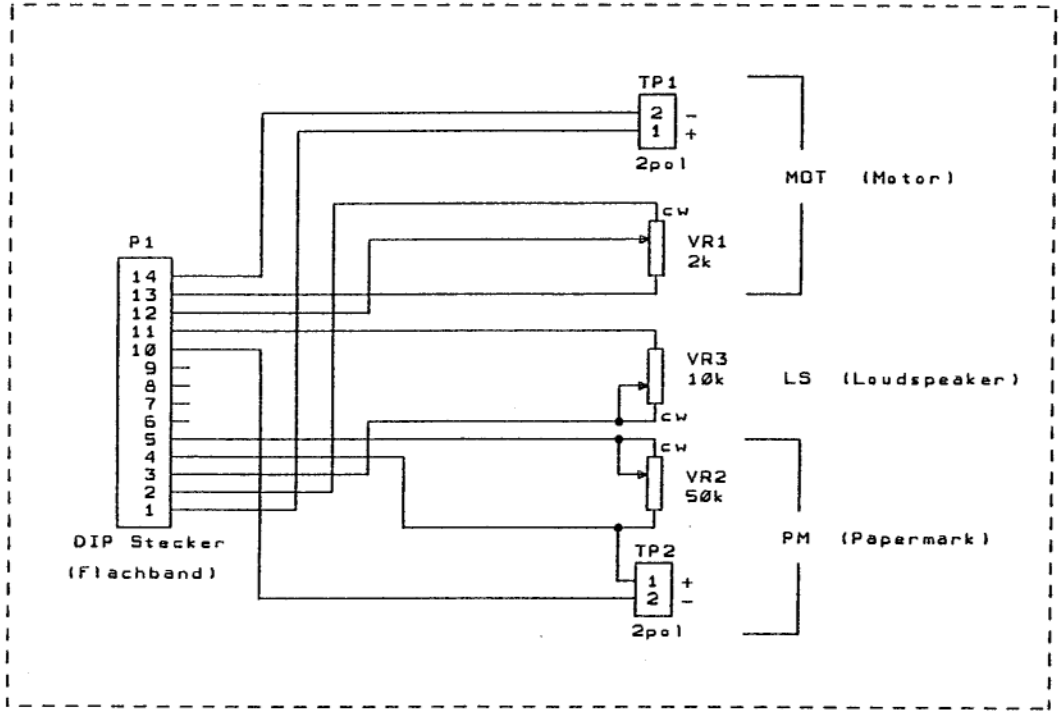
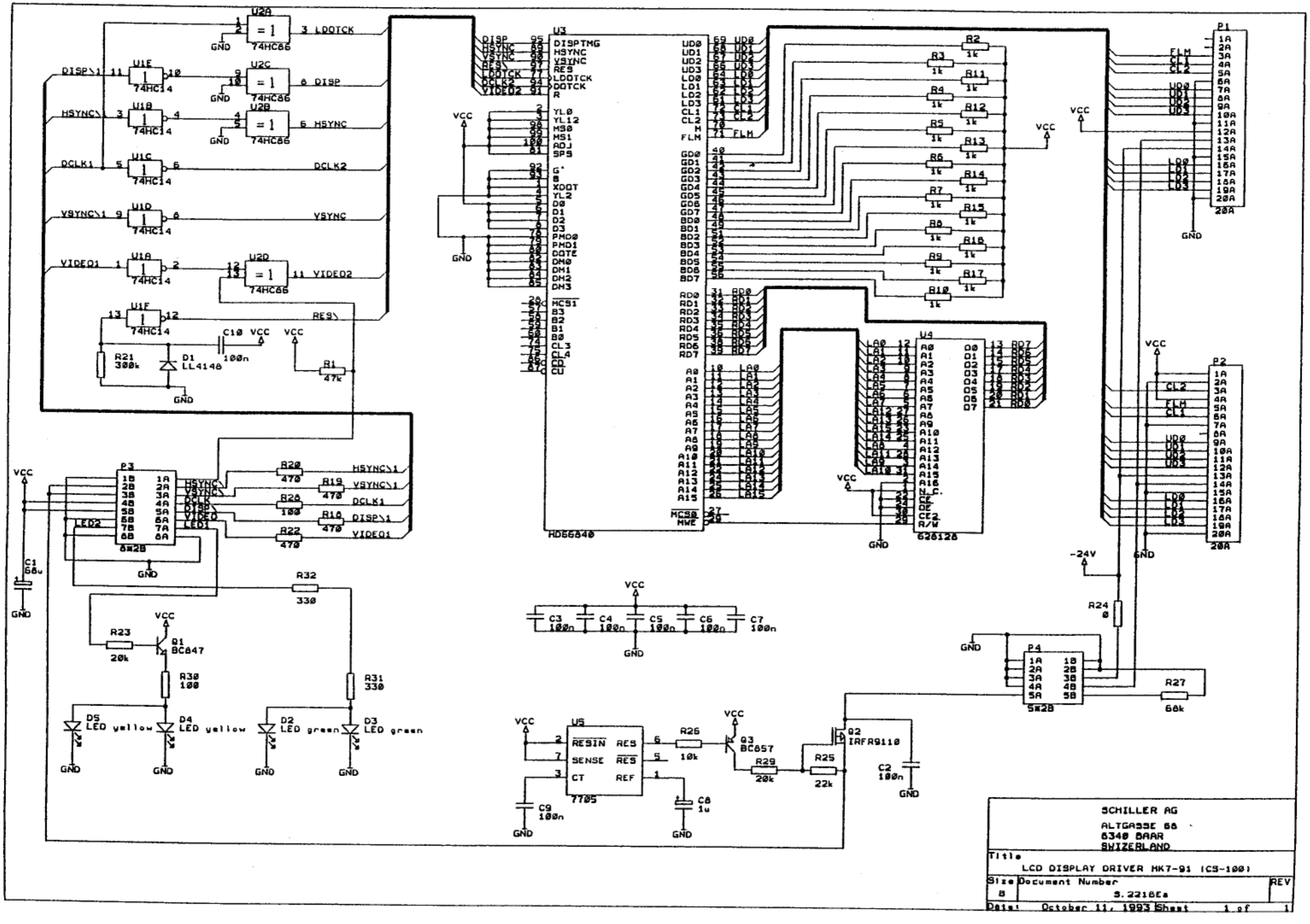
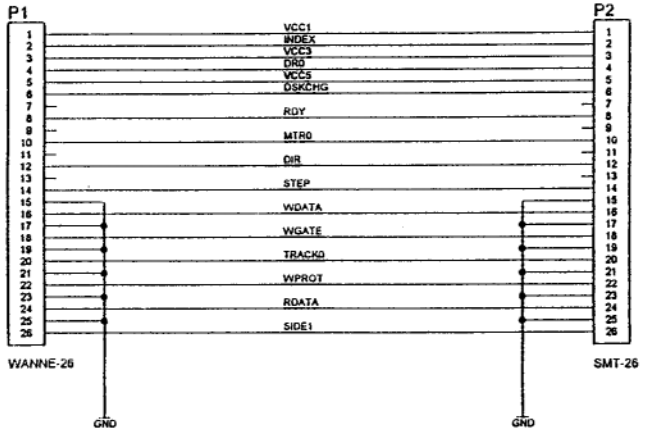
Date: October 11, 1993 Sheet 1 of 1


DC-IN 1/2
P1
DIN 5P
DC1+
DC2+
DC1-
DC2-
R8 48V
R7 48V
R10 48V
R9 48V
R3
R4
R5
R6
1k
C7 C8 C9 C10
1n
DCIN1+
DCIN2+
DCIN1-
DCIN2-
CAVE
DC-IN 3/4
P2
DIN 5P
DC3+
DC4+
DC3-
DC4-
R16 48V
R15 48V
R18 48V
R17 48V
R11
R12
R13
R14
C11 C12 C13 C14
DCIN3+
DCIN4+
DCIN3-
DCIN4-
DC-IN 5/6
P3
DIN 5P
DC5+
DC6+
DC5-
DC6-
R24 48V
R23 48V
R26 48V
R25 48V
R19
R20
R21
R22
C15 C16 C17 C18
DCIN5+
DCIN6+
DCIN5-
DCIN6-
DC-IN 1-6
P4
DIN 7P
DC1+
DC2+
DC3+
DC4+
DC5+
DC6+
N9
KABEL
ART.NR. 4.520 416
ERGO ANALOG
P5
DIN 5P
RPMIN
LOADIN
LOADOUT
R27 48V
R32 48V
R34 48V
R1
R2
R33
C1
C19
C2
47n
1n
DATA I/O
P6
DIN 7P
QTRG
FSIN
TMDN
TMUP
R28 48V
R29 48V
R31 48V
R30 48V
R35
R36
R37
R38
R42
R39
R40
R41
47R
C3 C4 C5 C6
KEYBOARD
P7
DIN 5P
PCKBCLK
PCKBD
PCKBRES
PCKB+5V
R43 48V
R53 48V
R45 48V
R44 48V
R46
R48
R47
R49
R51
R50
R52
1R
C21 C22 C23 C20
N8
KABEL
ART.NR. 4.520 415
Title DC FILTERPRINT MK7-48 (AT-60)
Size: A3
Nr: S.2227Aa
Revision:
Drawn by: L.Strasser
Date: 20-Feb-1996
Sheet 1 of 1
Schiller AG
Altgasse 68
CH-6340 Baar
Switzerland



SCHILLER AG Altgasse 68a CH - 6340 BAAR Switzerland		
Title: Externe Trimmer MK7-51 (AT-60)		
Size: A	Document Number: S.2221Aa	REV
Date: October 7, 1993	Sheet 1 of 1	

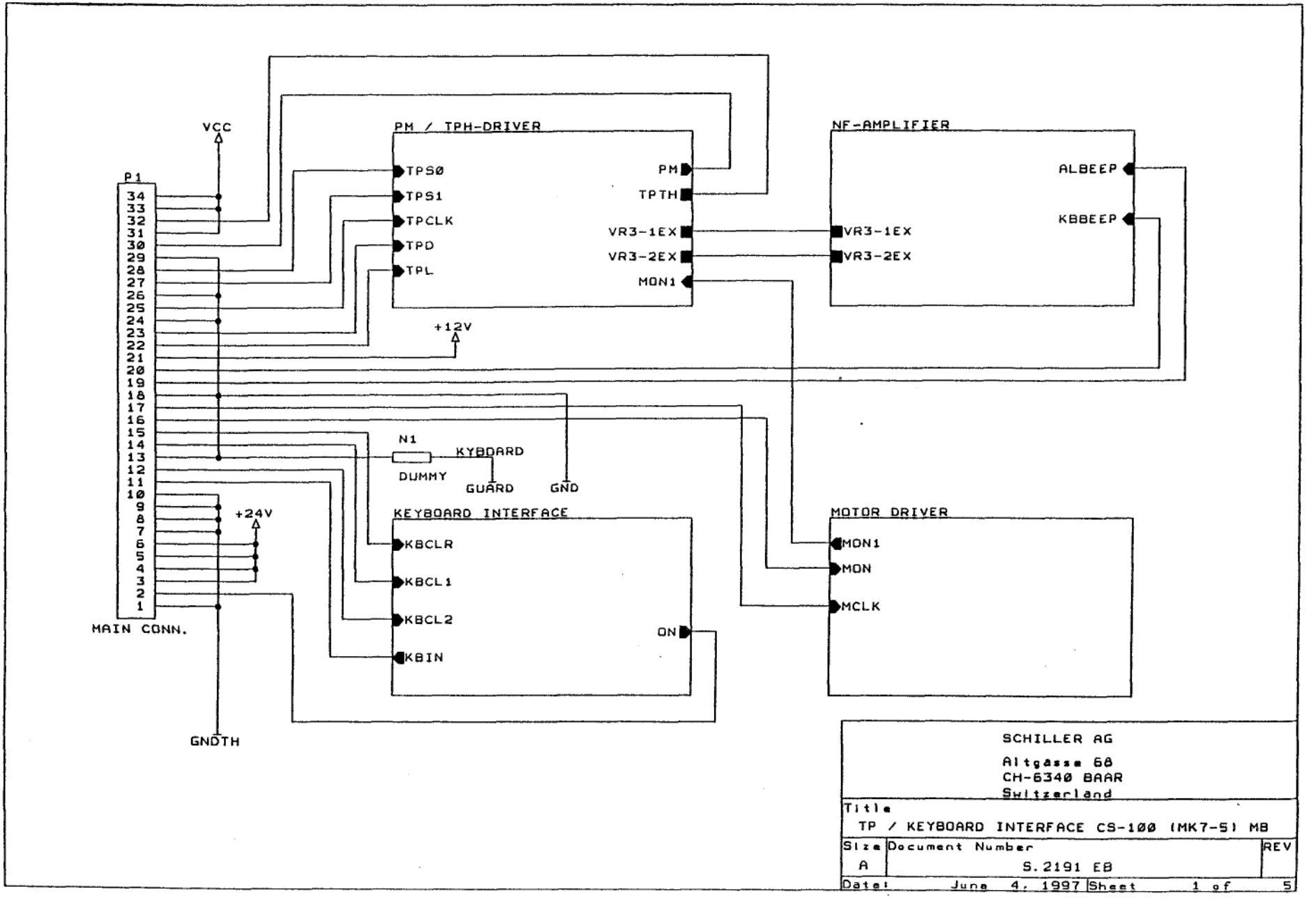

SCHILLER AG
ALTGASSE 68
6340 BAAR
SWITZERLAND
Title
LCD DISPLAY DRIVER MK7-91 (CS-100)
Size B
Document Number 5.2216Ea
REV
Date: October 11, 1993 Sheet 1 of 1
HD66840
7705
74HC14
74HC86
8x2B
5x2B
628128
BC847
BC857
IRF9110
LL4148
LED yellow
LED green
VCC
GND
-24V



Floppy - Connector	MK7-131	(AT-60)		S.2215Aa	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 26.08.96	Sheet 1 of 1	

AT-60 Circuit Diagrams and Board Layouts

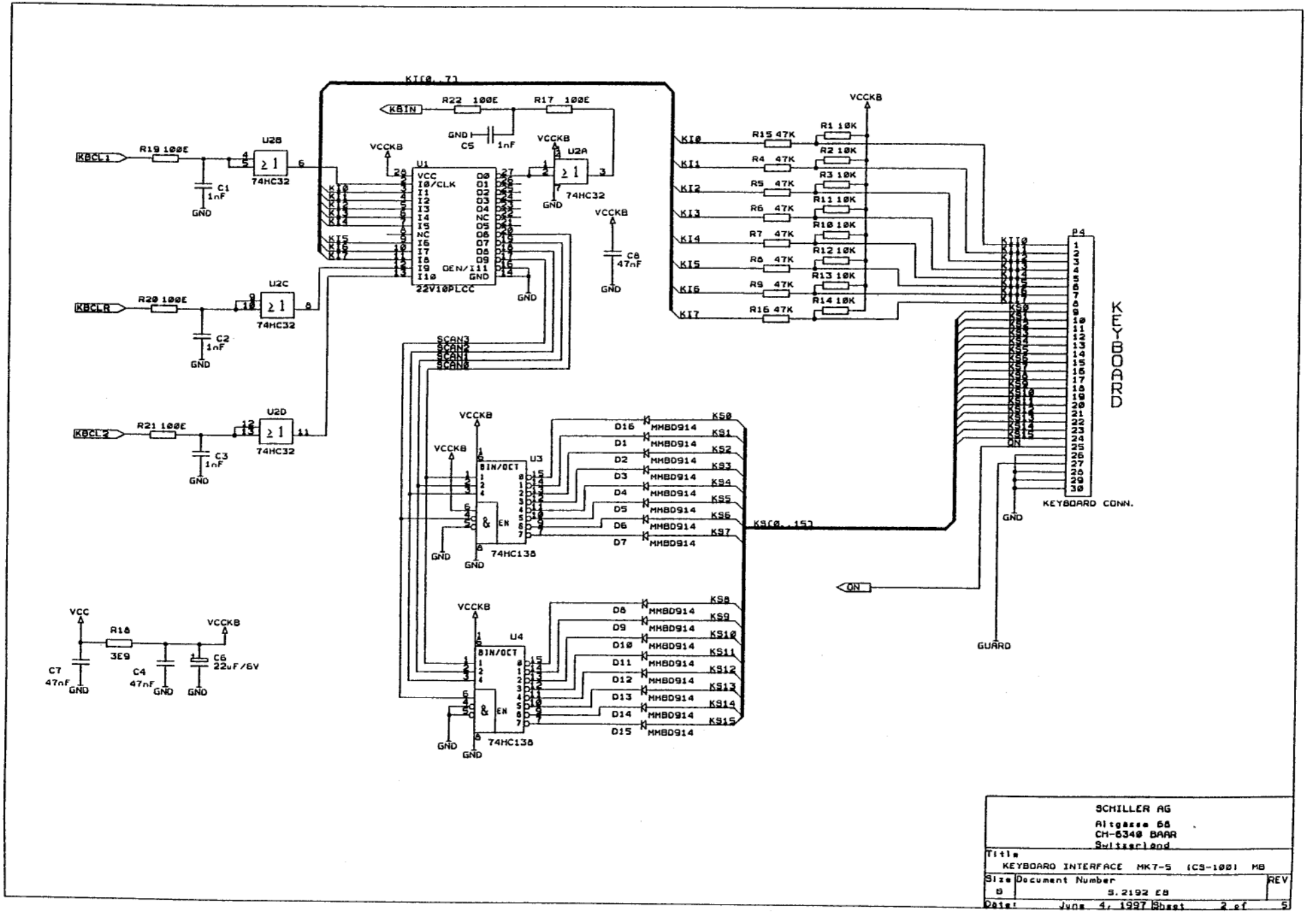
Keyboard Interface, Thermal Printer Control and Audio Amplifier MK 7-5



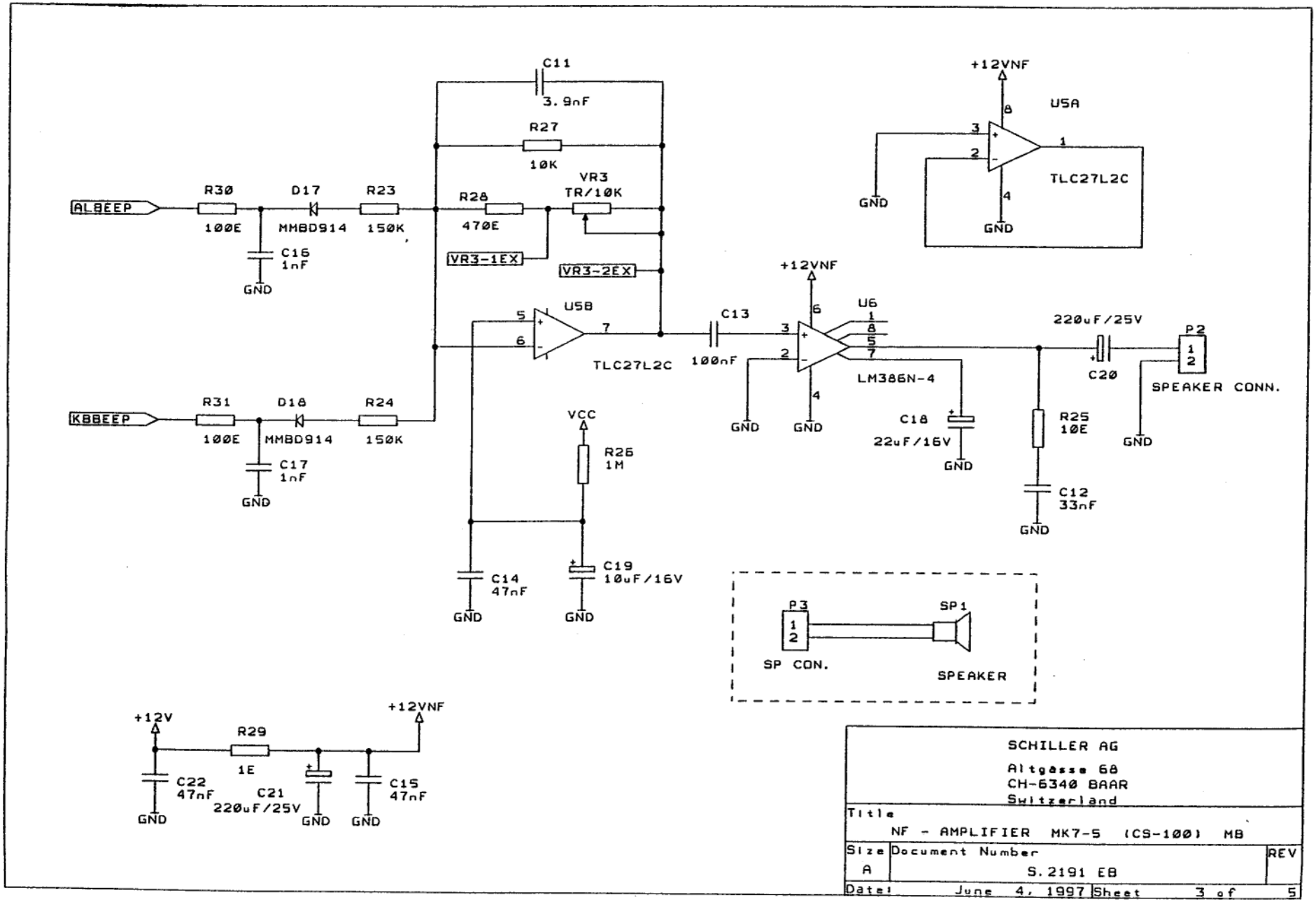
SCHILLER AG

Altgasse 68
CH-6340 BAAR
Switzerland

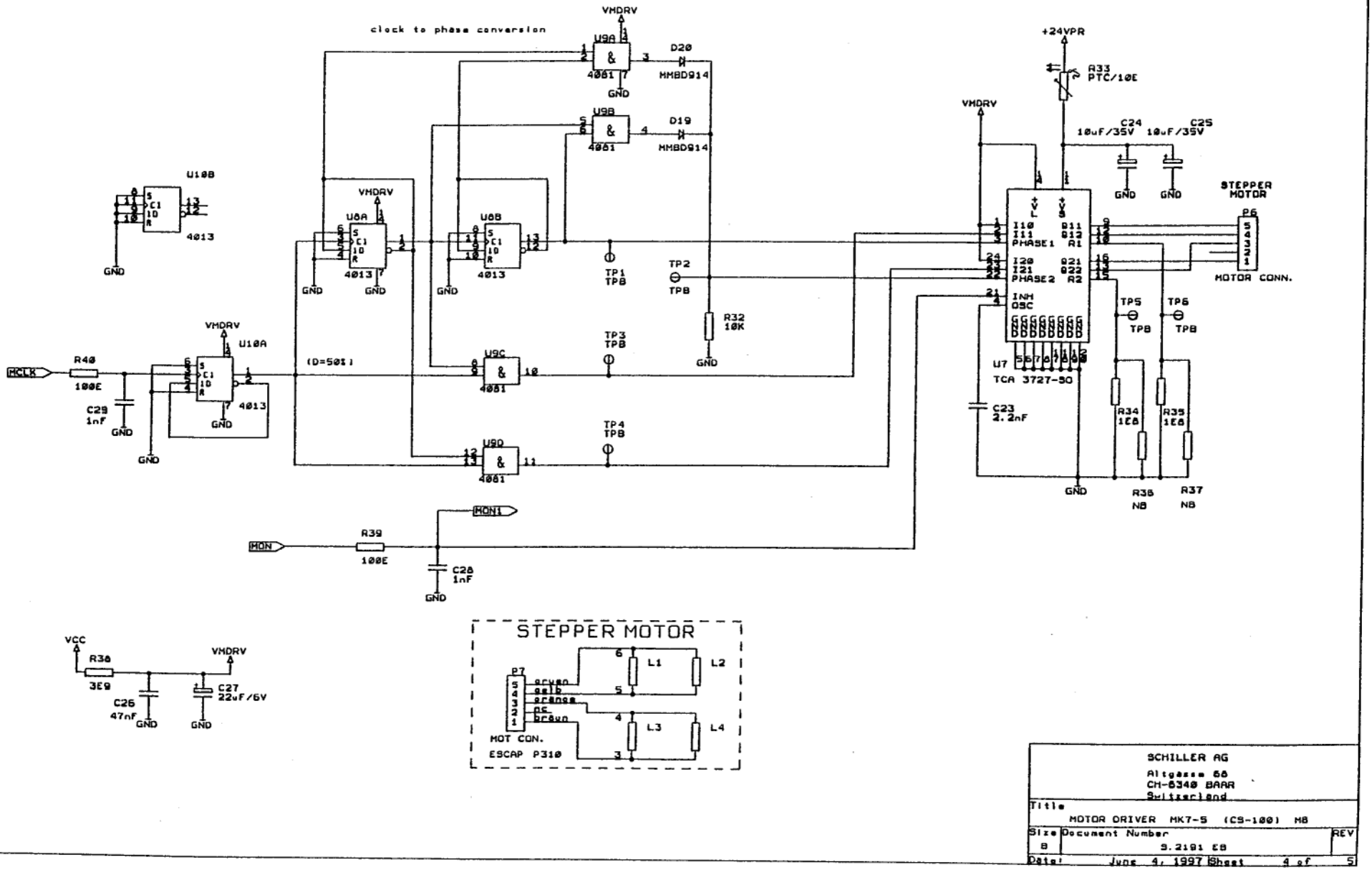
Title: TP / KEYBOARD INTERFACE CS-100 (MK7-5) MB		
Size: A	Document Number: S.2191 EB	REV:
Date: June 4, 1997	Sheet 1 of 5	



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
Title KEYBOARD INTERFACE MK7-5 (CS-100) MB		
Size B	Document Number 5.2192.68	REV
Date: June 4, 1997	Sheet 2 of 5	



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland		
Title: NF - AMPLIFIER MK7-5 (CS-100) MB		
Size: A	Document Number: S.2191 EB	REV
Date: June 4, 1997	Sheet 3 of 5	

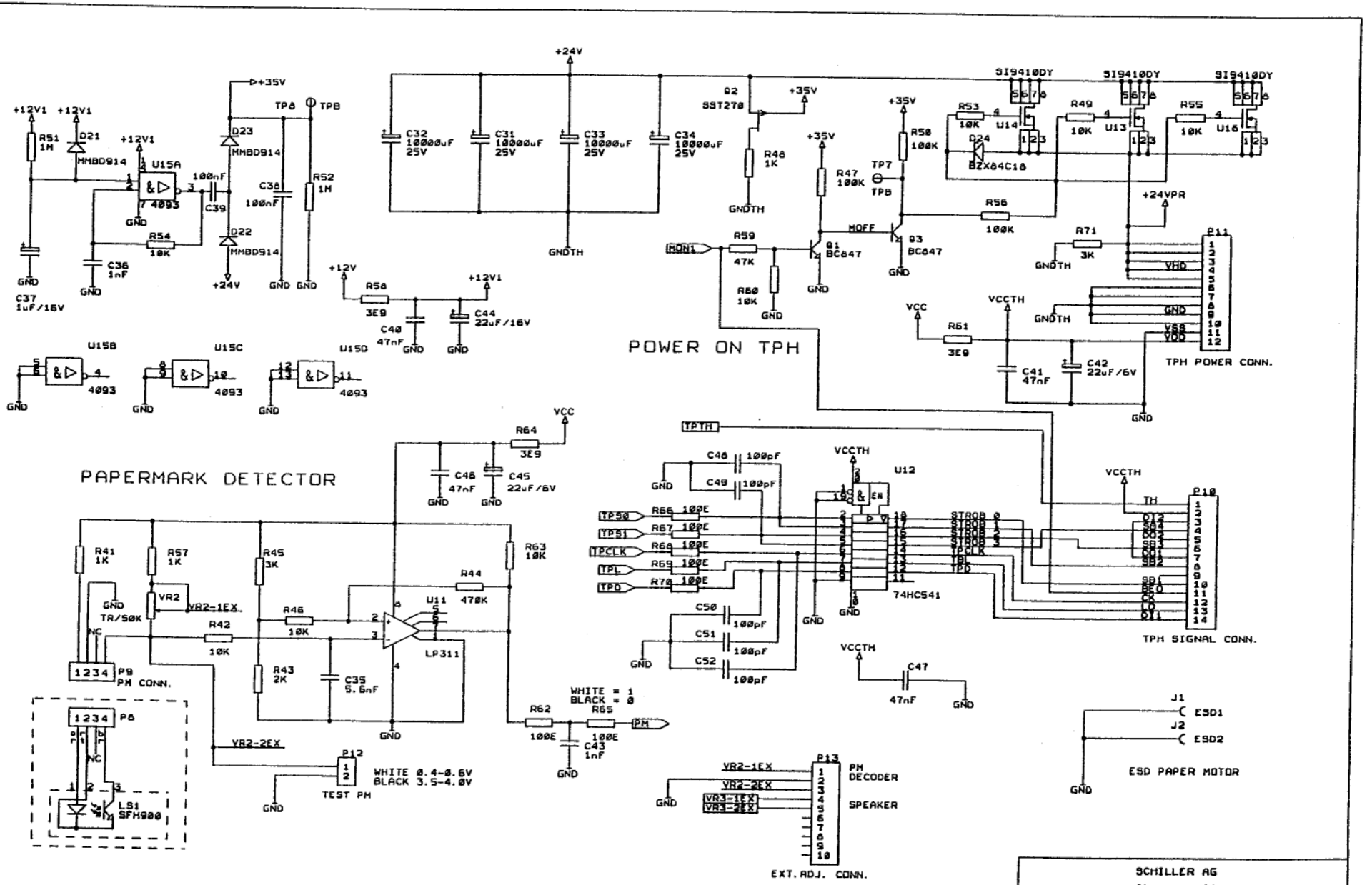


SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland

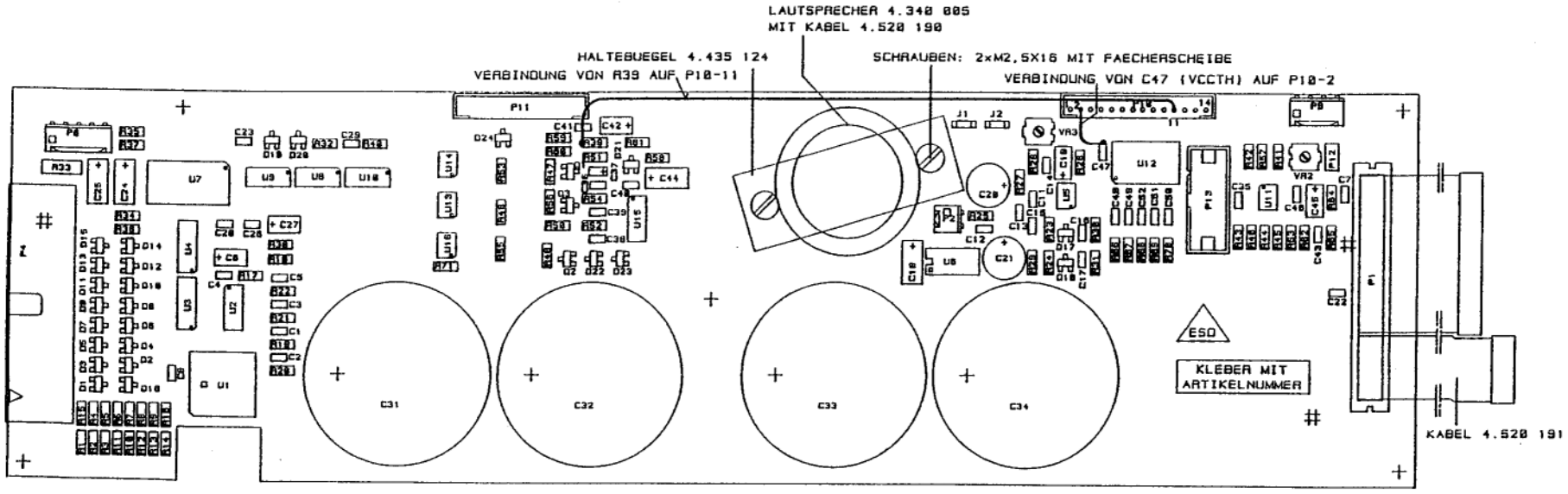
Title
MOTOR DRIVER MK7-S (CS-100) M8

Size	Document Number	REV
B	5.2191.68	

Date: June 4, 1997 Sheet 4 of 5



SCHILLER AG Altgasse 68 CH-6340 BAAR Switzerland	
Title: PM / TPH-DRIVER MK7-S (CS-100) MB	
Size: B	Document Number: S.2191 EB — REV
Date: June 4, 1997	Sheet 5 of 5



BESTUECKUNGSVARIANTEN:

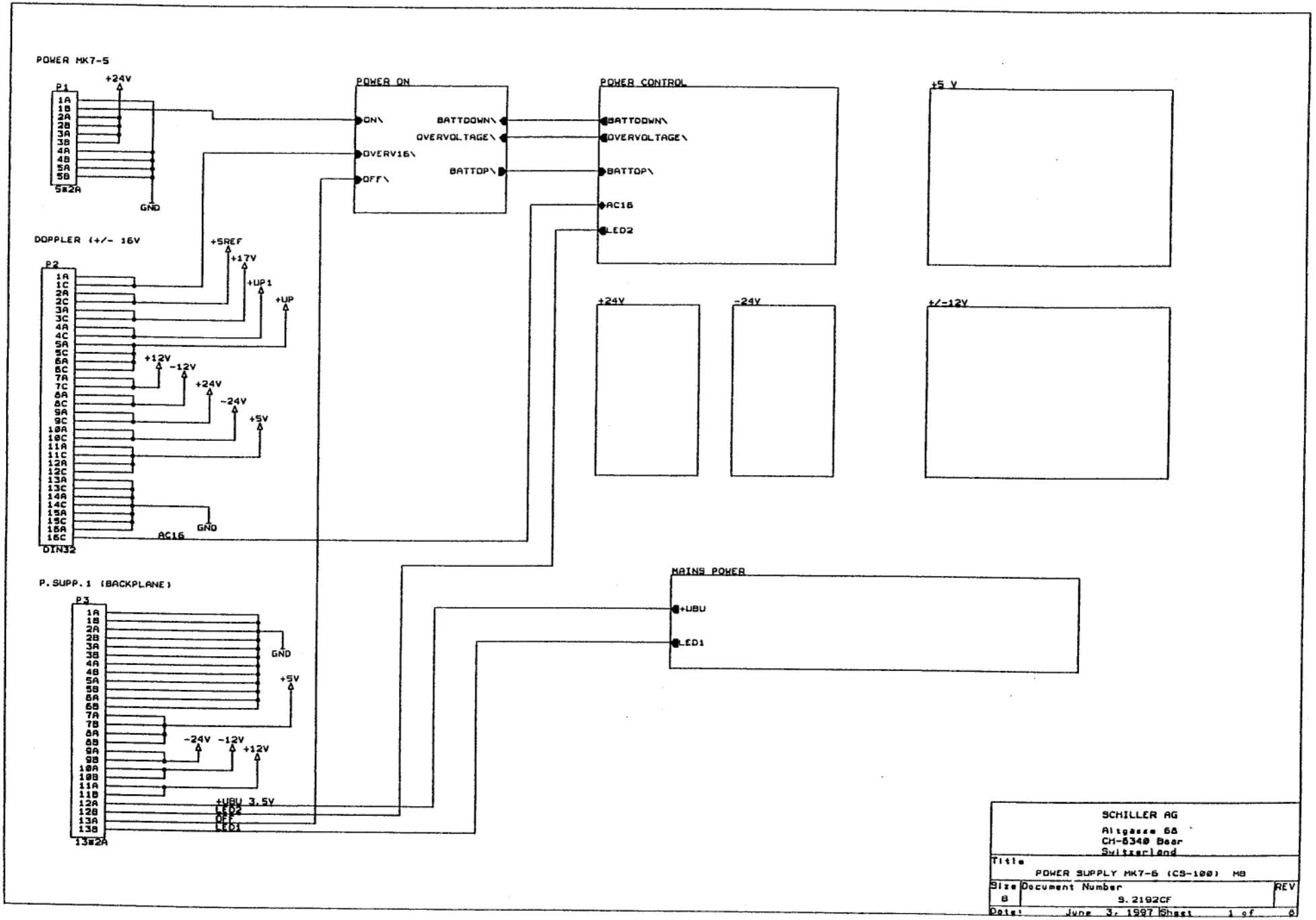
A) CS100 3.2191
- P13 NICHT BESTUECKEN

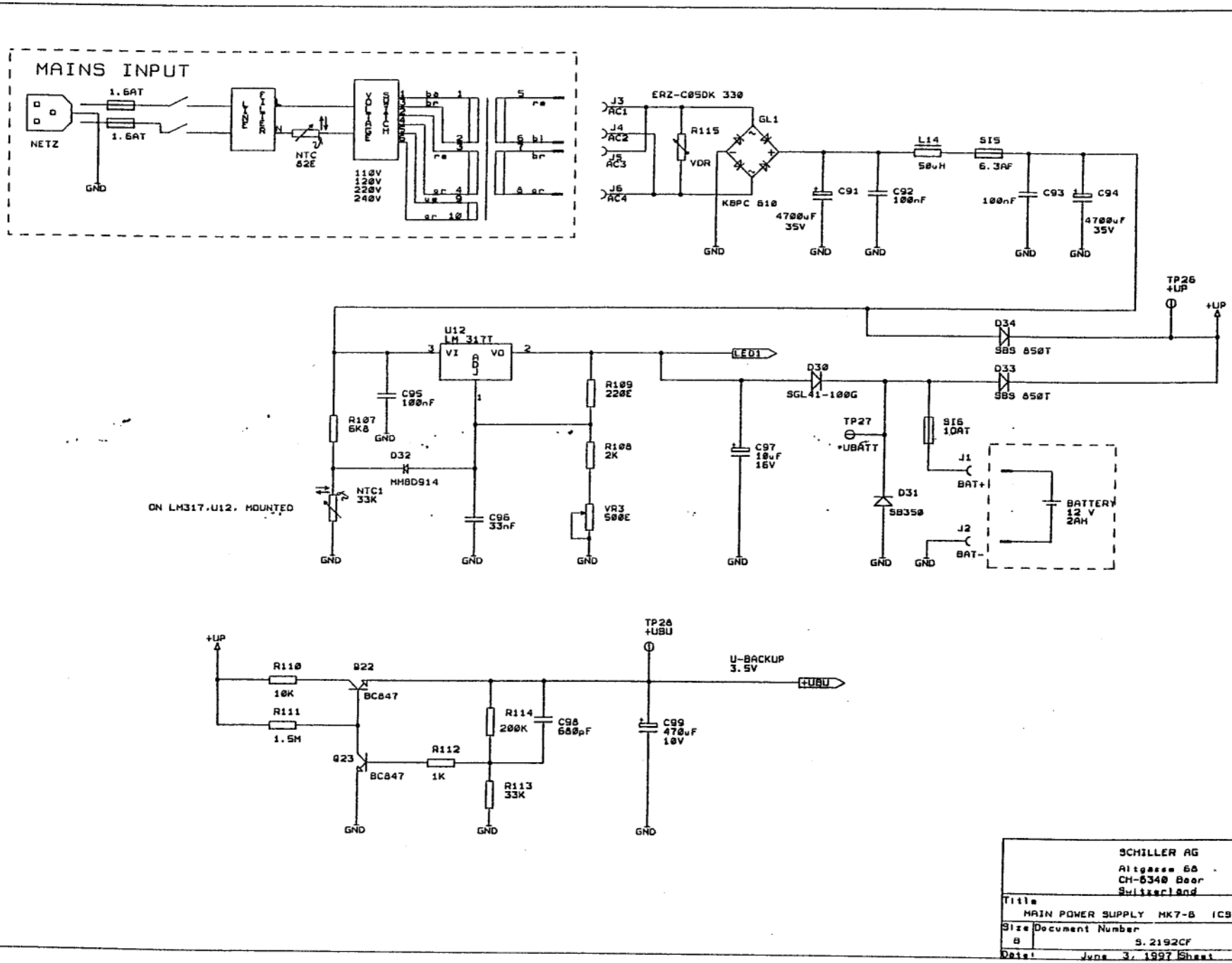
B) AT-60 3.2202
- P13 BESTUECKEN
- VR2, VR3 NICHT BESTUECKEN

SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : STR. Entw : Prod :
Title KEYBOARD INTERFACE MK7-5		CS-100
Size	Document Number 0.2191EB	
Date: 04.06.1997	Sheet	1 of 2

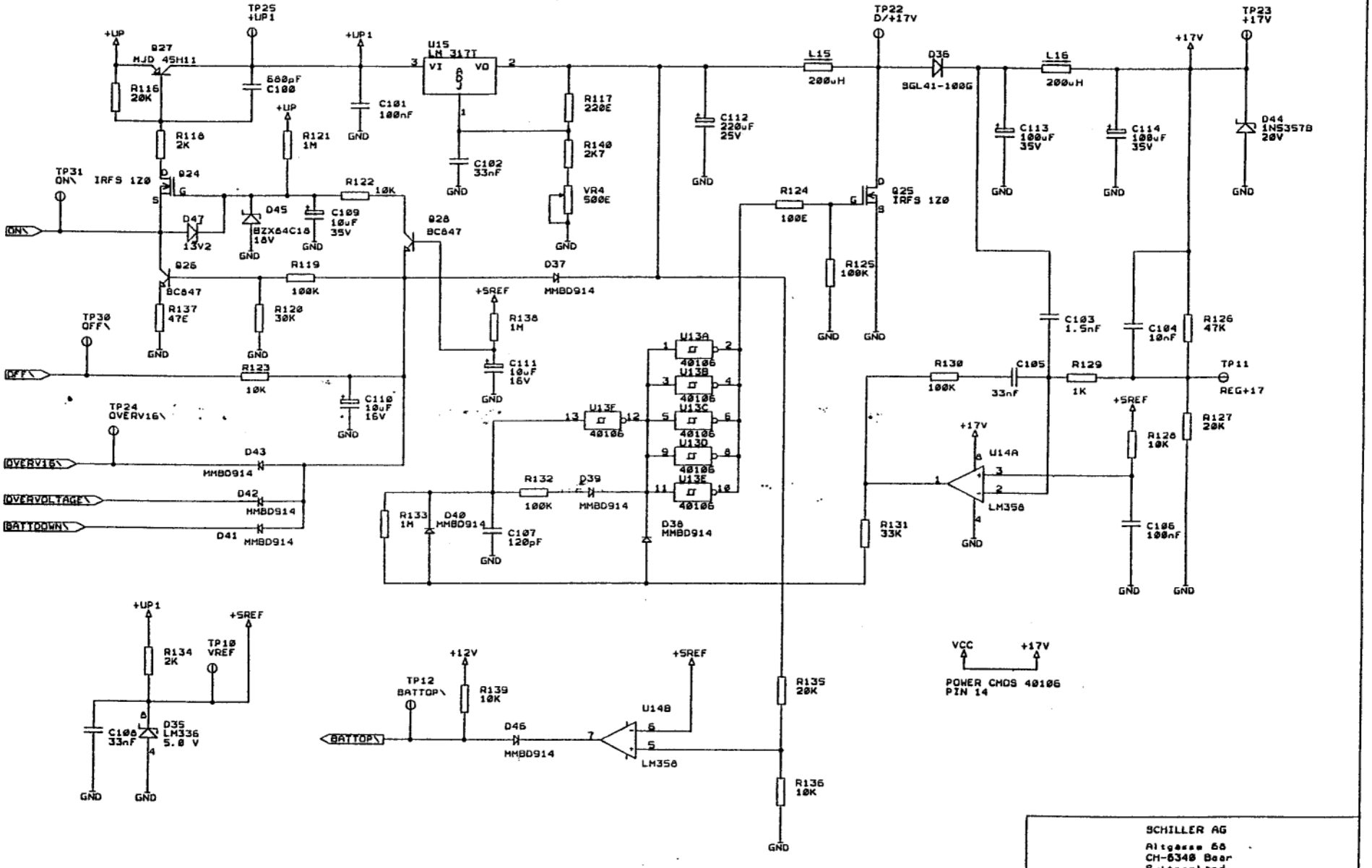
AT-60 Circuit Diagrams and Board Layouts

Power Supply MK 7-6

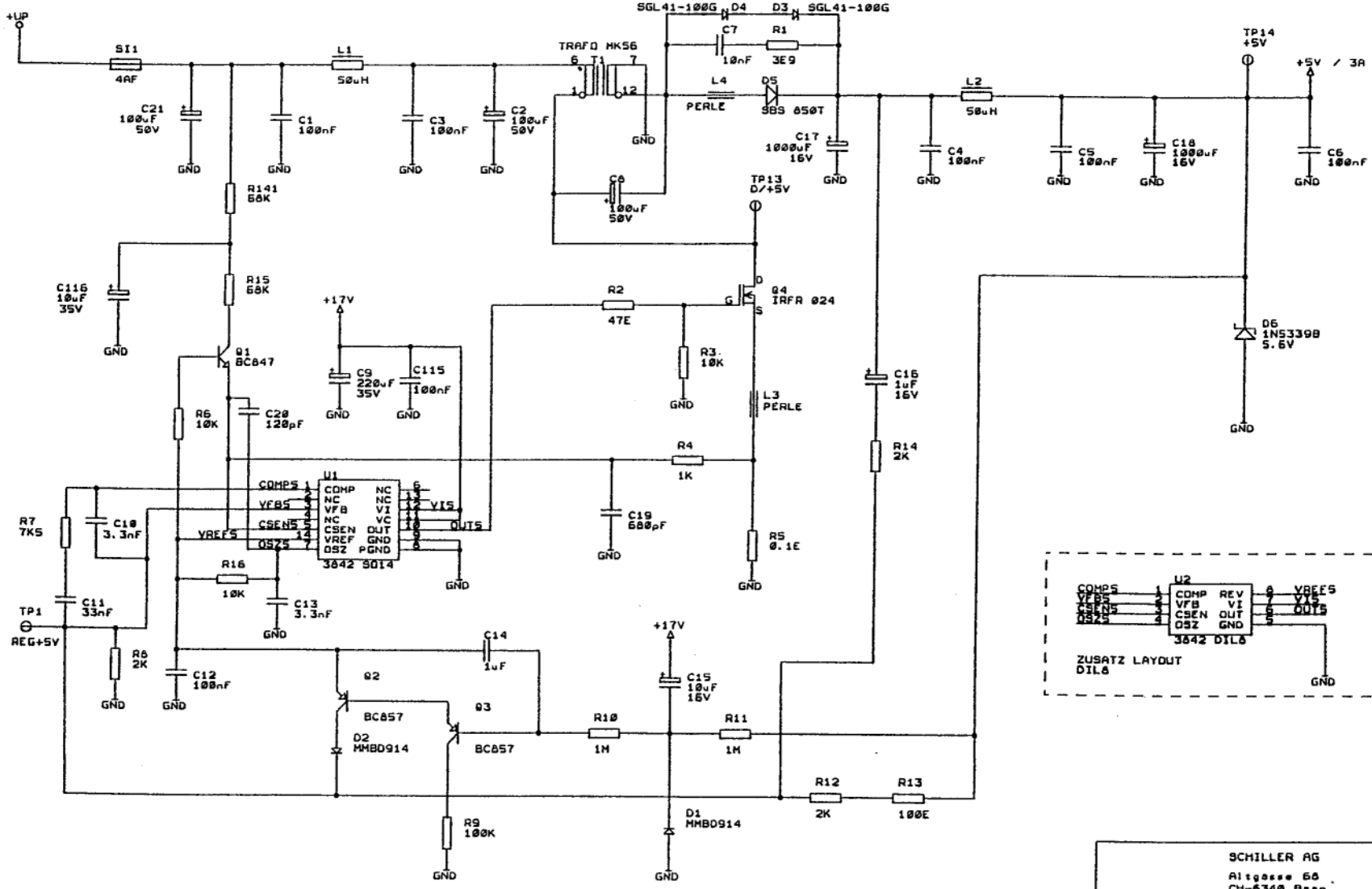

POWER MK7-5
P1
+24V
1A
1B
2A
2B
3A
3B
4A
4B
5A
5B
5x2A
GND
POWER ON
ON\
OVERV16\
OFF\
BATTDOWN\
OVERVOLTAGE\
BATTOP\
POWER CONTROL
BATTDOWN\
OVERVOLTAGE\
BATTOP\
AC16
LED2
+5 V
DOPPLER (+/- 16V
P2
+SREF
+17V
+UP1
+UP
+12V
-12V
+24V
-24V
+5V
GND
AC16
DIN32
+24V
-24V
+/-12V
P. SUPP. 1 (BACKPLANE)
P3
GND
+5V
-24V
-12V
+12V
+UBU 3.5V
LED2
OFF
LED1
13x2A
MAINS POWER
+UBU
LED1
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
POWER SUPPLY MK7-6 (CS-100) MB
Size
B
Document Number
S.2192CF
REV
Date: June 3, 1997
Sheet 1 of 0



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland	
Title: MAIN POWER SUPPLY MK7-8 IC9-1001 MB	
Size: B	Document Number: 5.2192CF — REV
Date: June 3, 1997	Sheet 2 of 8



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		
Title: POWER ON MK7-6 (C9-100) MB		
Size: B	Document Number: S.2192CF	REV:
Date: June 3, 1997	Sheet 3 of 8	



SCHILLER AG
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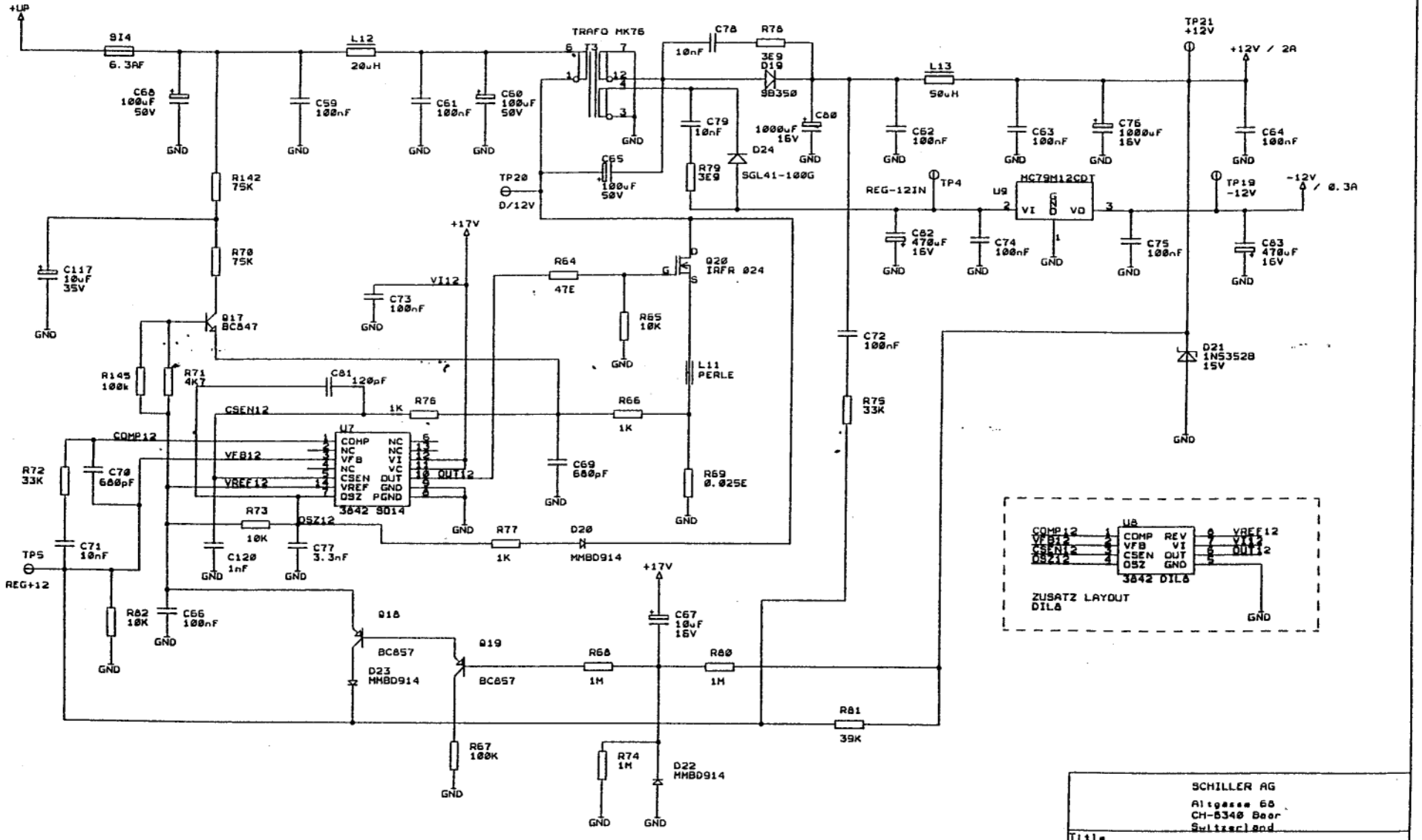
CH-6340 Baar
Switzerland

Title
+5V SWITCHING REGULATOR MK7-6 (CS-100) MB

Size	Document Number	REV
B	5.2192CF	
Date: June 3, 1997	Sheet 5 of 8	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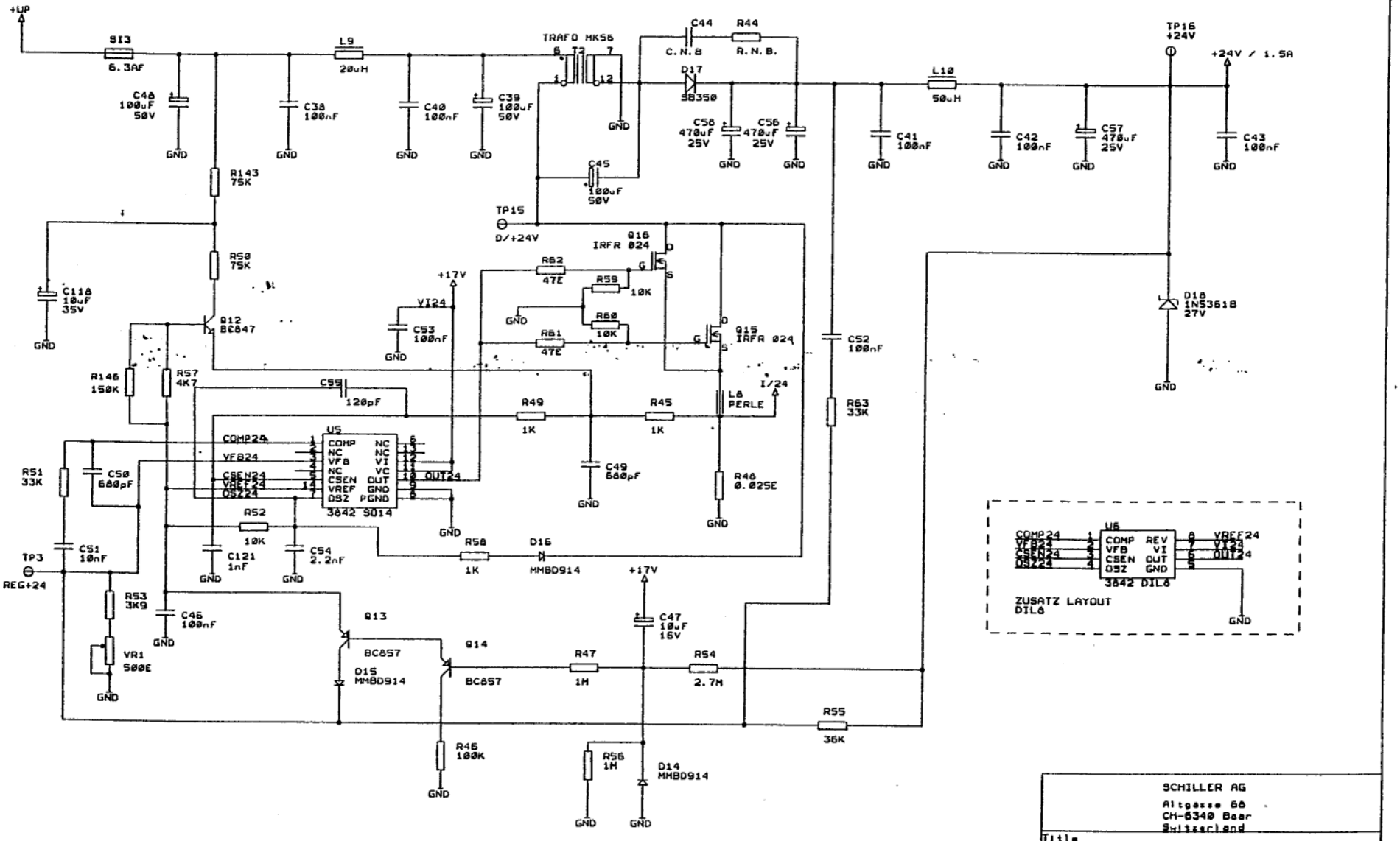
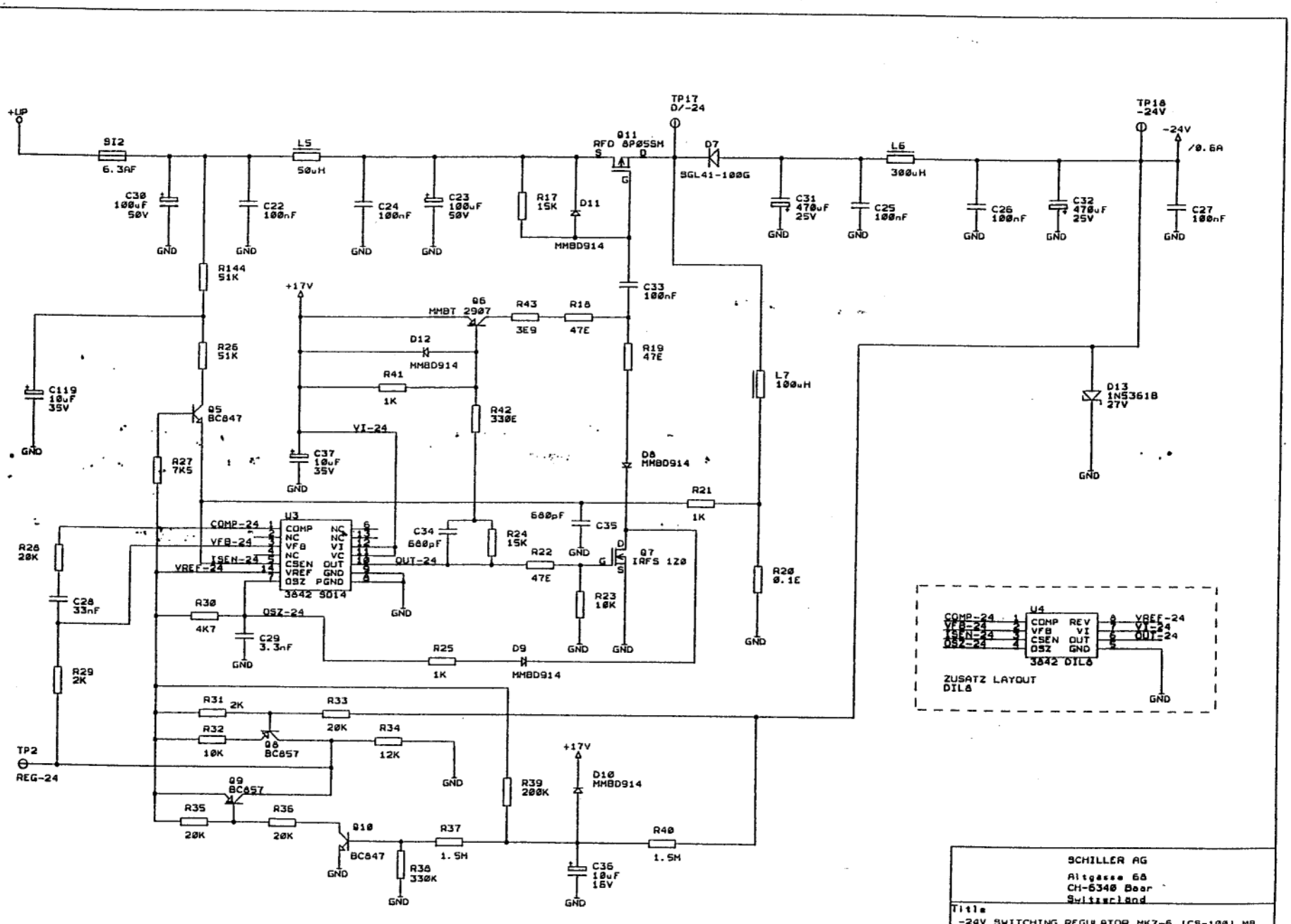
SI4
6.3AF
L12
20uH
TRAFO MK76
C78
10nF
R78
3E9
D19
9B350
L13
50uH
TP21
+12V
+12V / 2A
C68
100uF
50V
C59
100nF
C61
100nF
C60
100uF
50V
C79
10nF
C80
1000uF
16V
C62
100nF
C63
100nF
C76
1000uF
16V
C64
100nF
C65
100uF
50V
R79
3E9
D24
SGL41-100G
TP20
D/12V
REG-12IN
TP4
U9
MC79M12CDT
VI
GND
VO
TP19
-12V
-12V / 0.3A
C82
470uF
16V
C74
100nF
C75
100nF
C83
470uF
16V
R142
75K
R70
75K
C117
10uF
35V
Q17
BC847
+17V
VI12
C73
100nF
R64
47E
Q20
IRFR 024
R65
10K
L11
PERLE
C72
100nF
D21
1N5352B
15V
R145
100k
R71
4K7
C81
120pF
CSEN12
R76
1K
R66
1K
R75
33K
COMP12
VFB12
VREF12
U7
COMP
NC
VFB
NC
CSEN
VREF
OSZ
NC
VI
VC
OUT
GND
PGND
OUT12
3842 SO14
R72
33K
C70
680pF
C69
680pF
R69
0.025E
R73
10K
OSZ12
C120
1nF
C77
3.3nF
R77
1K
D20
MMBD914
TP5
REG+12
C71
10nF
R82
10K
C66
100nF
Q18
BC857
Q19
BC857
D23
MMBD914
+17V
C67
10uF
16V
R68
1M
R80
1M
R81
39K
R67
100K
R74
1M
D22
MMBD914
U8
COMP
VFB
CSEN
OSZ
REV
VI
OUT
GND
3842 DIL8
ZUSATZ LAYOUT
DIL8
GND
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
+/-12V SWITCHING REGULATOR MK7-6 (C9-100) MB
Size
B
Document Number
S.2192CF
REV
Date: June 3, 1997 Sheet 6 of 8


+UP
SI3
6.3AF
L9
20uH
TRAFO MK56
C44
C.N.8
R44
R.N.B.
D17
SB350
L10
50uH
TP16
+24V
+24V / 1.5A
C40
100uF
50V
C38
100nF
C40
100nF
C39
100uF
50V
C58
470uF
25V
C56
470uF
25V
C41
100nF
C42
100nF
C57
470uF
25V
C43
100nF
GND
C45
100uF
50V
TP15
D/+24V
R143
75K
R50
75K
C118
10uF
35V
Q12
BC847
Q16
IRFR 024
R62
47E
R59
10K
R60
10K
R61
47E
Q15
IRFR 024
+17V
VI24
C53
100nF
D18
1N5361B
27V
C52
100nF
R63
33K
I/24
L8
PERLE
R146
150K
R57
4K7
C59
120pF
R49
1K
R45
1K
U5
3842 SO14
COMP24
VFB24
CSEN24
VREF24
OSZ24
OUT24
C49
680pF
R48
0.025E
R51
33K
C50
680pF
R52
10K
C121
1nF
C54
2.2nF
R58
1K
D16
MMBD914
TP3
REG+24
C51
10nF
R53
3K9
VR1
500E
C46
100nF
Q13
BC857
Q14
BC857
D15
MMBD914
C47
10uF
16V
R47
1M
R54
2.7M
R55
36K
R46
100K
R56
1M
D14
MMBD914
U6
3842 DIL8
ZUSATZ LAYOUT
DIL8
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
+24V SWITCHING REGULATOR MK7-6 (C9-100) MB
Size
B
Document Number
9.2192CF
REV
Date: June 3, 1997
Sheet 7 of 8



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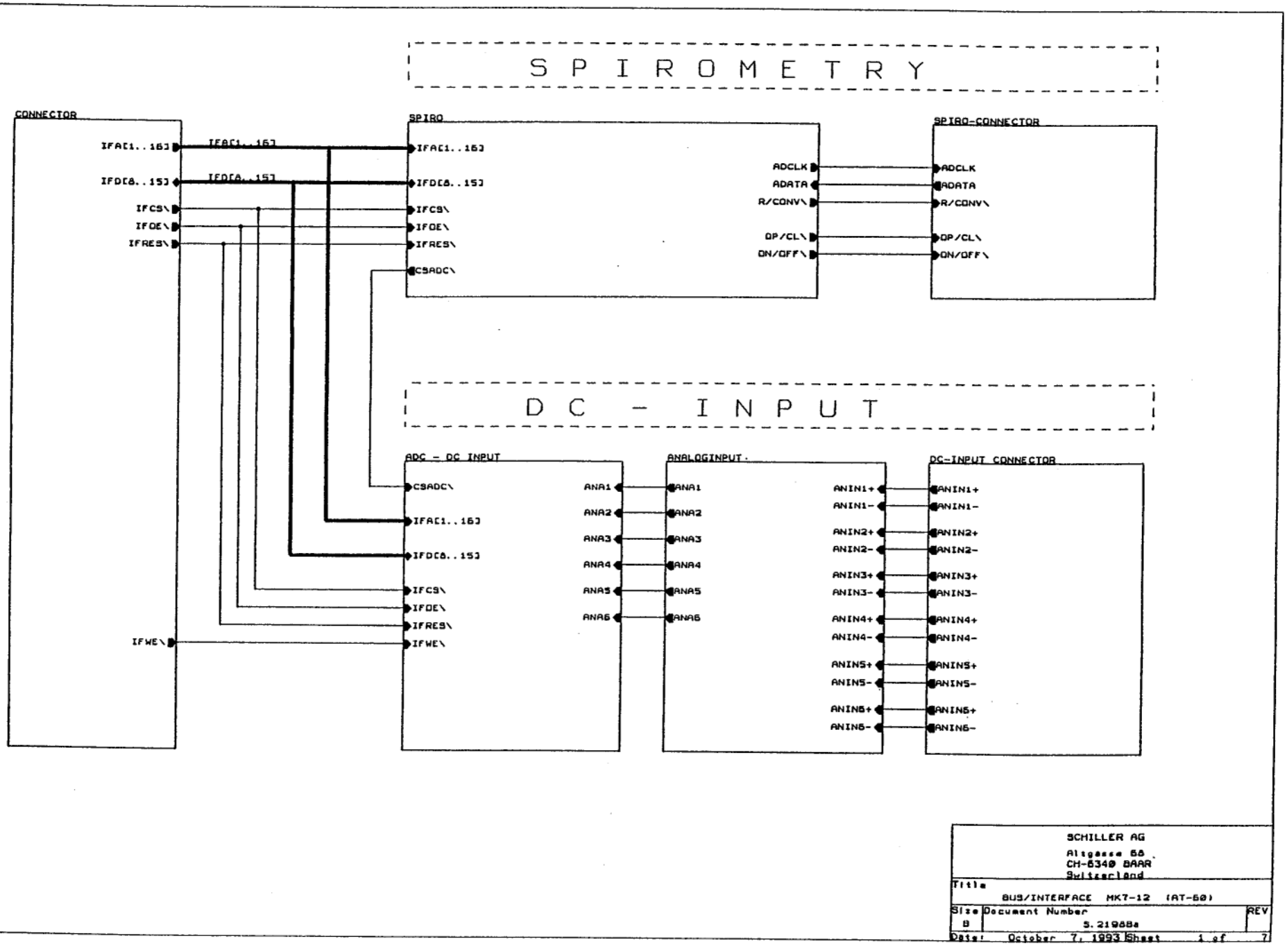
Title	-24V SWITCHING REGULATOR MK7-6 (CS-100) MB	
Size B	Document Number S.2192CF	REV
Date: June 3, 1997	Sheet 8 of 8	

AT-60 Circuit Diagrams and Board Layouts

Bus Interface MK 7-12



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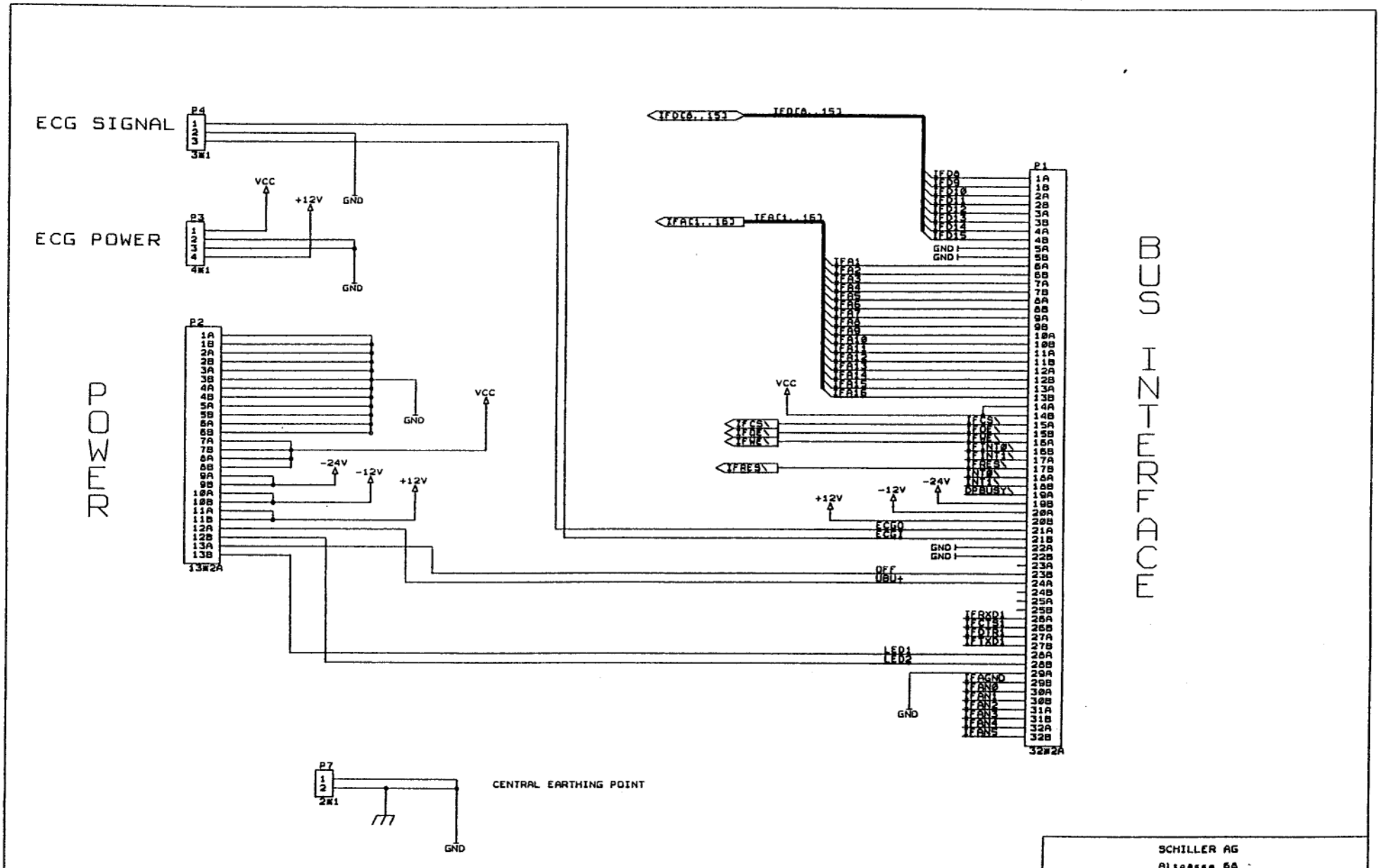
Switzerland

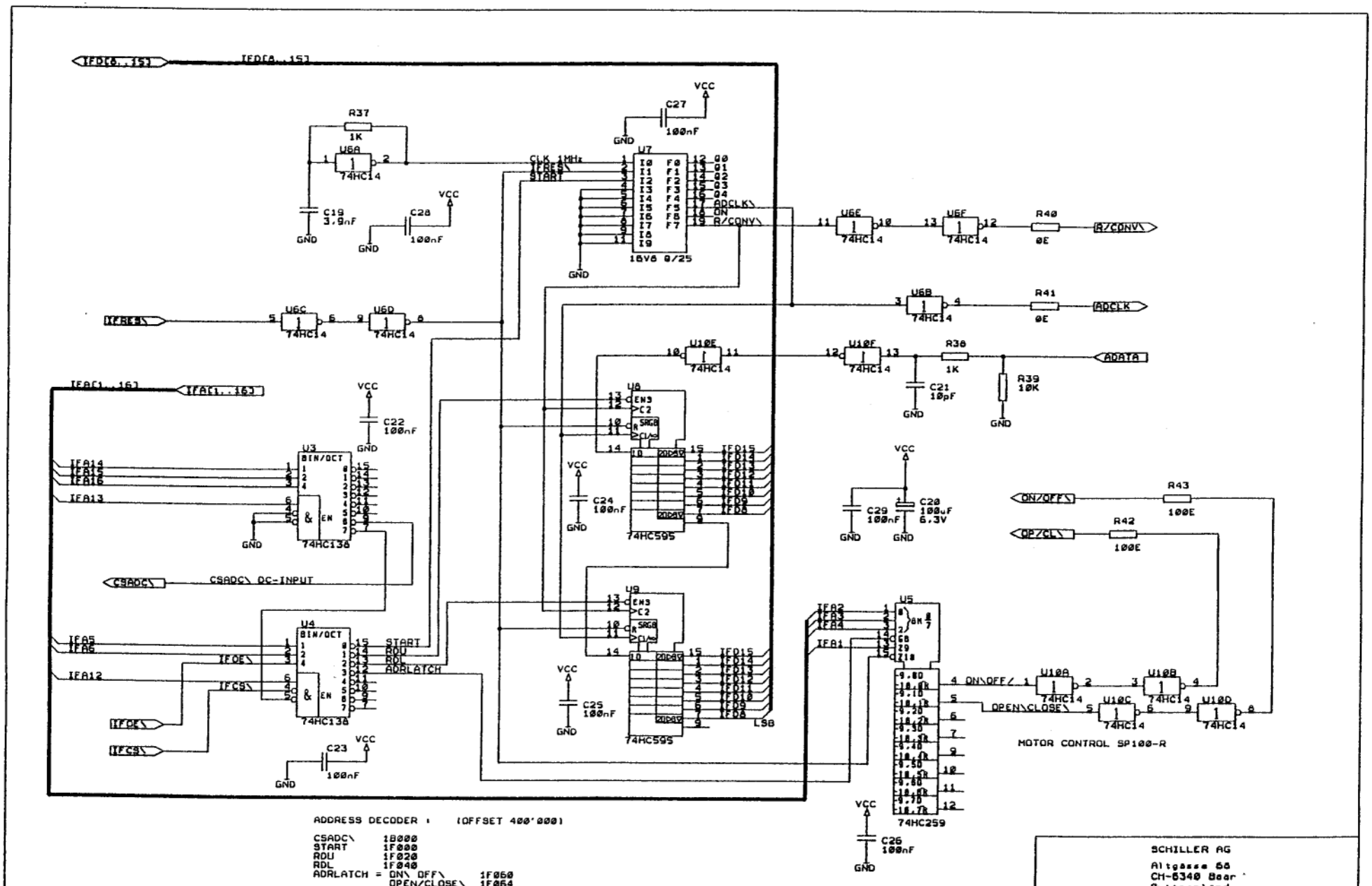
Title
BUS/INTERFACE MK7-12 (AT-60)

Size	Document Number	REV
B	5.21988a	

Date: October 7, 1993 Sheet 1 of 7



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		
Title BUS CONNECTOR MK7-12 (AT-60) MB		
Size B	Document Number 9.21988a	REV
Date: October 7, 1993	Sheet 2 of 7	



ADDRESS DECODER : (OFFSET 400'000)

CSADC\	18000
START	1F000
RDU	1F020
RDL	1F040
ADRLATCH = ON\ OFF\	1F060
OPEN/CLOSE\	1F064

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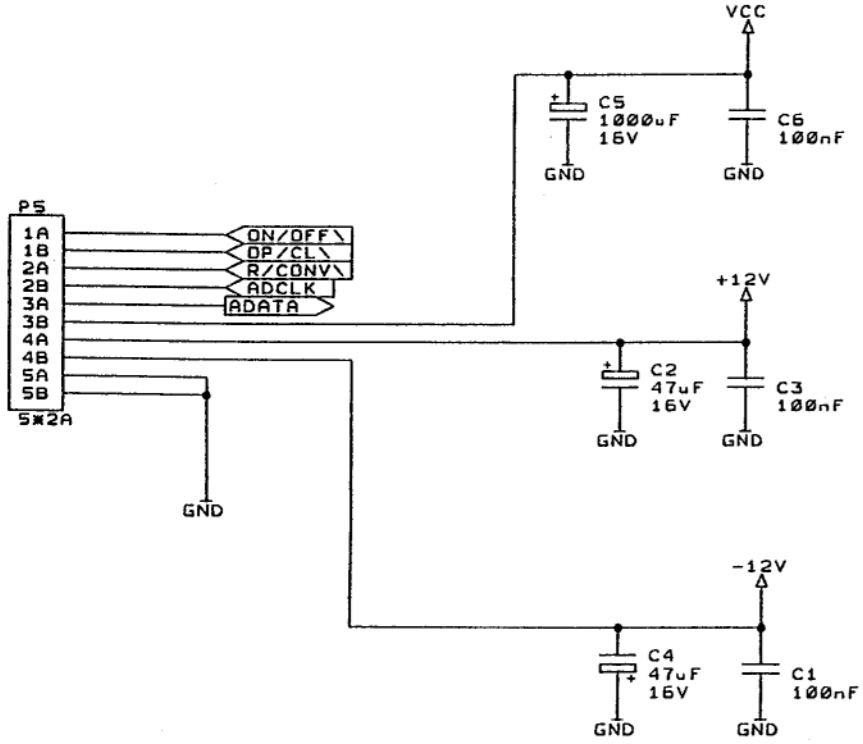
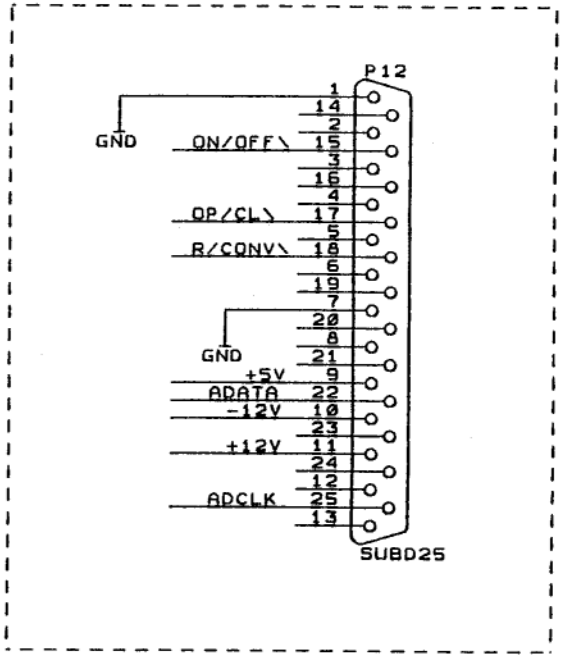
CH-6340 Baar
Switzerland

Title
INTERFACE SP100 / R MK7-12 (AT-60) MB

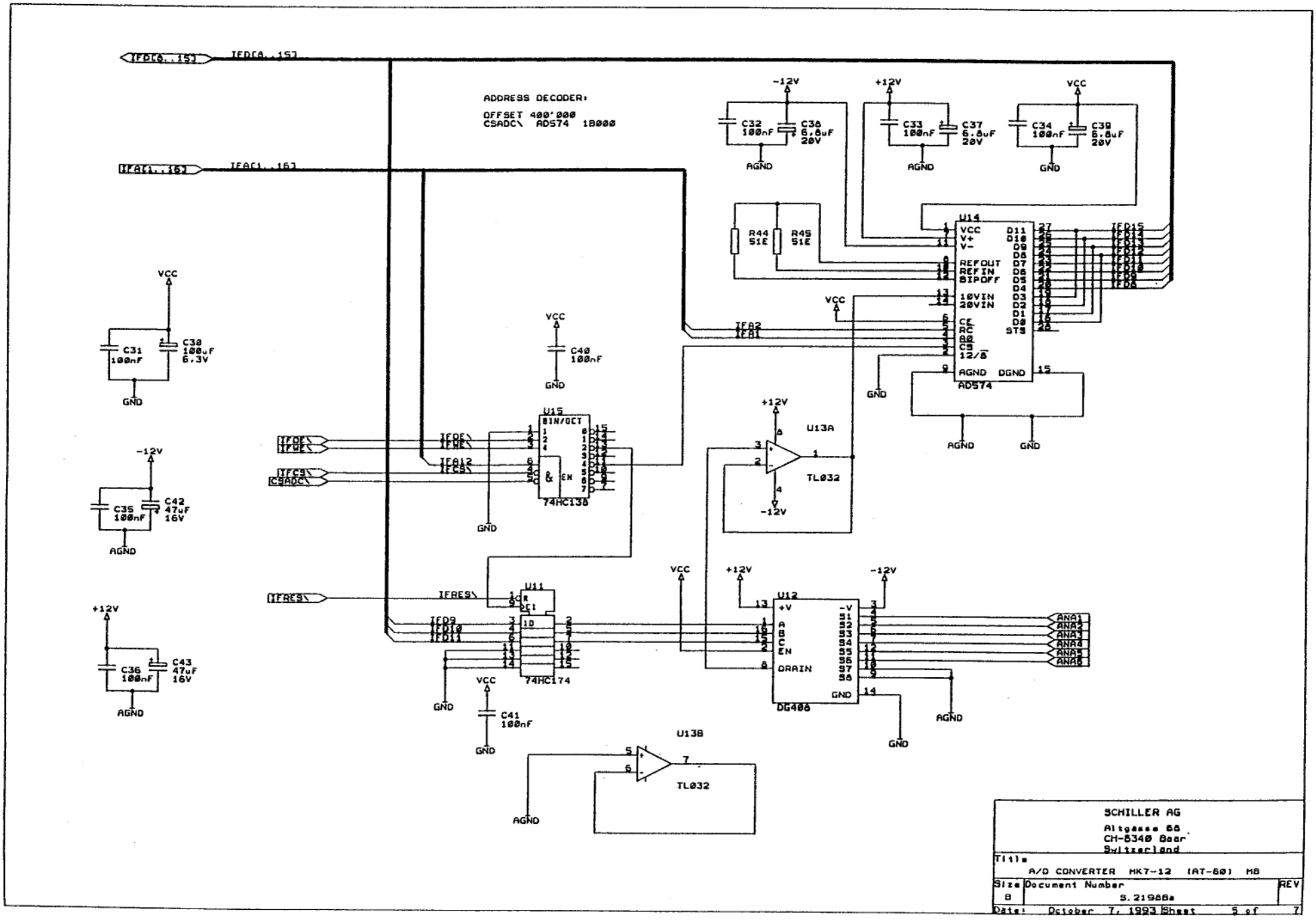
Size	Document Number	REV
B	5.21988a	

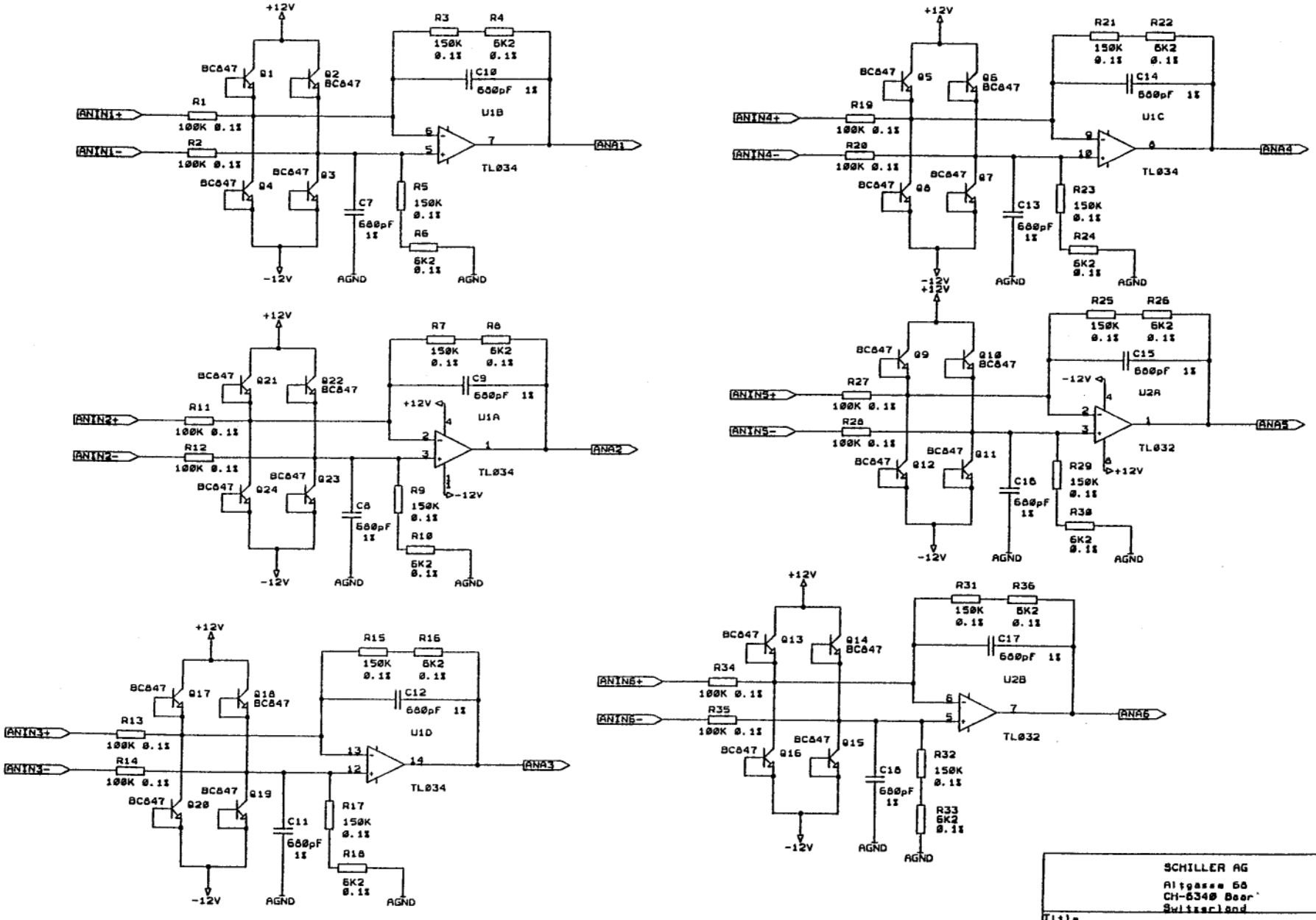
Date: October 7, 1993 Sheet 3 of 7





SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		
Title CONNETOR SP100/R MK7-12 (AT-60) MB		
Size A	Document Number S.2198Ba	REV
Date: October 7, 1993	Sheet 4 of 7	


IFD[0..15]
IFD[0..15]
IFA[1..16]
IFA[1..16]
ADDRESS DECODER:
OFFSET 400'000
CSADC\ AD574 1B000
-12V
+12V
VCC
C32 100nF
C38 6.8uF 20V
C33 100nF
C37 6.8uF 20V
C34 100nF
C39 6.8uF 20V
AGND
GND
R44 51E
R45 51E
U14
VCC
V+
V-
REFOUT
REFIN
BIPOFF
10VIN
20VIN
CE
RC
A0
CS
12/8
AGND
DGND
D11
D10
D9
D8
D7
D6
D5
D4
D3
D2
D1
D0
STS
AD574
IFD15
IFA2
IFA1
C31 100nF
C30 100uF 6.3V
C40 100nF
U15
BIN/OCT
74HC138
IFDE\
IFWE\
IFA12
IFCS\
CSADC\
U13A
TL032
C35 100nF
C42 47uF 16V
IFRES\
U11
74HC174
IFD9
IFD10
IFD11
U12
DG408
+V
-V
A
B
C
EN
DRAIN
ANA1
ANA2
ANA3
ANA4
ANA5
ANA6
C36 100nF
C43 47uF 16V
C41 100nF
U13B
TL032
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
A/D CONVERTER MK7-12 (AT-60) MB
Size
B
Document Number
5.21988a
REV
Date: October 7, 1993 Sheet 5 of 7

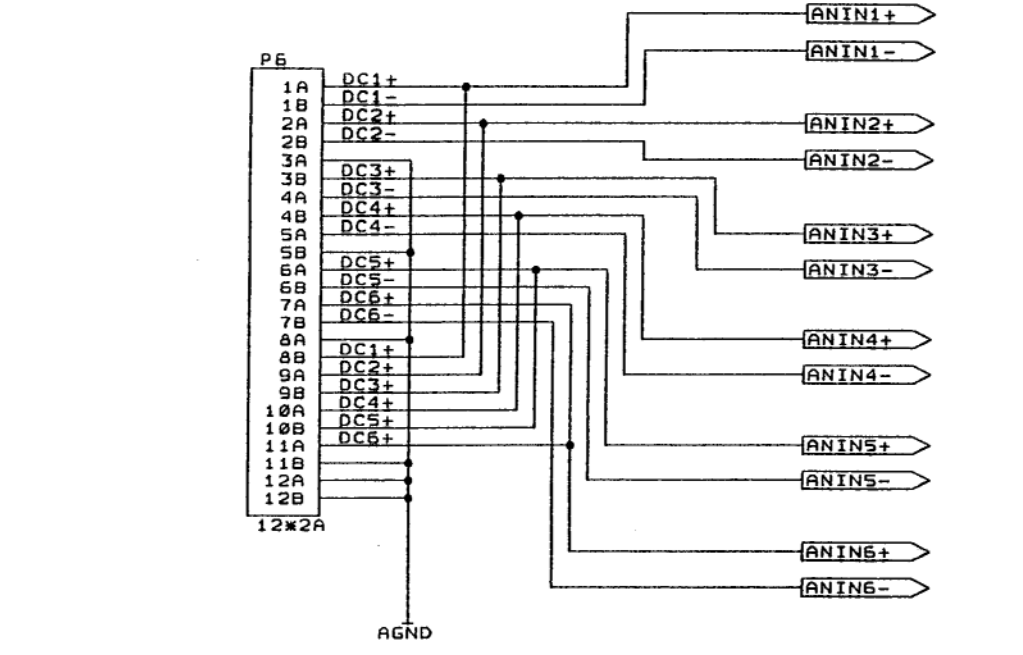


SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland

Title
DC - INPUT MK7-12 (AT-60) MB

Size	Document Number	REV
B	9.21988a	

Date: October 7, 1993 Sheet 6 of 7



FRONT VIEW

SCHILLER AG

Altgasse 68
CH-6340 Baar
Switzerland

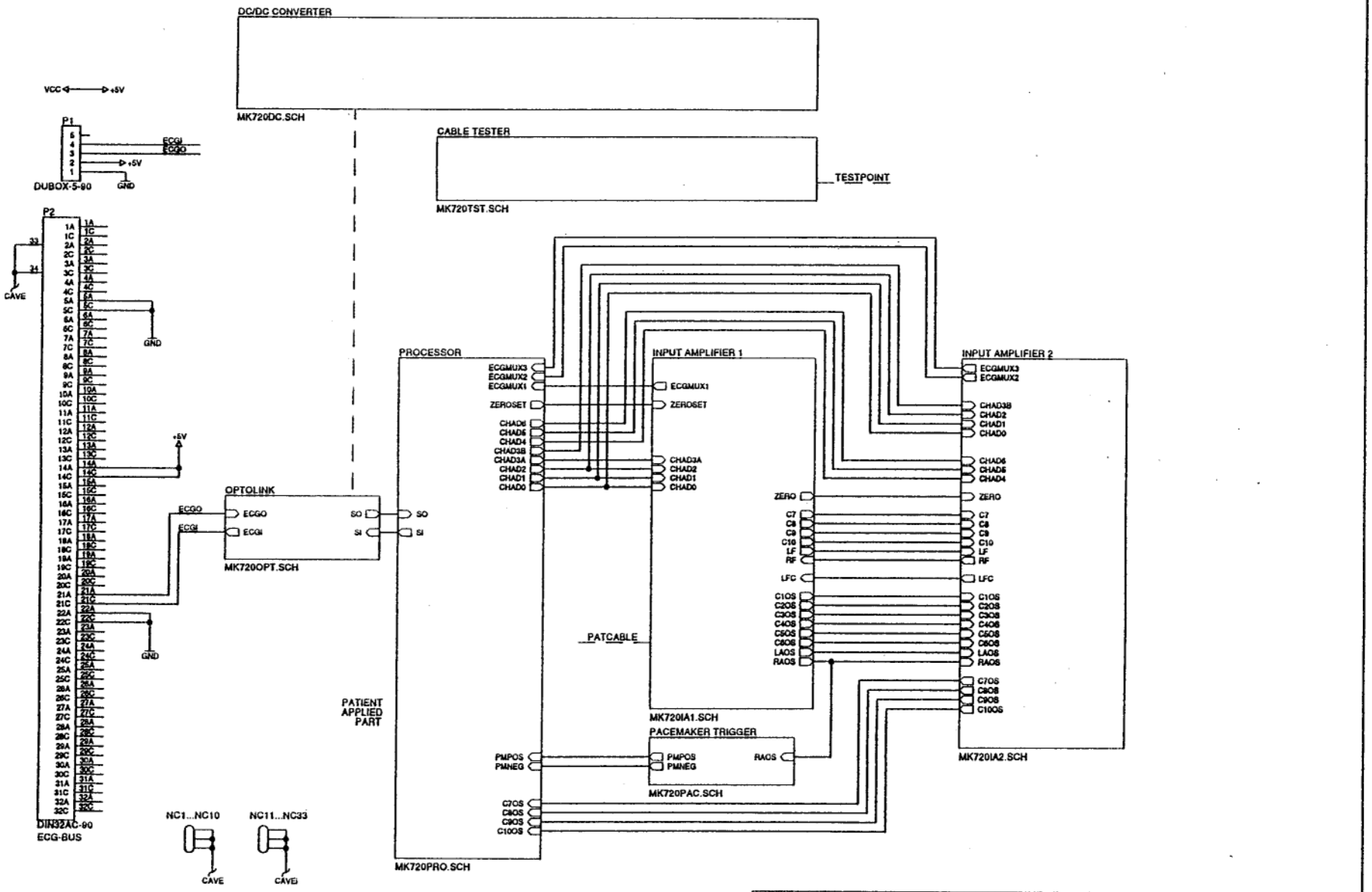
Title
CONNECTOR DC-INPUT MK7-12 (AT-60) MB

Size	Document Number	REV
A	S.21988a	

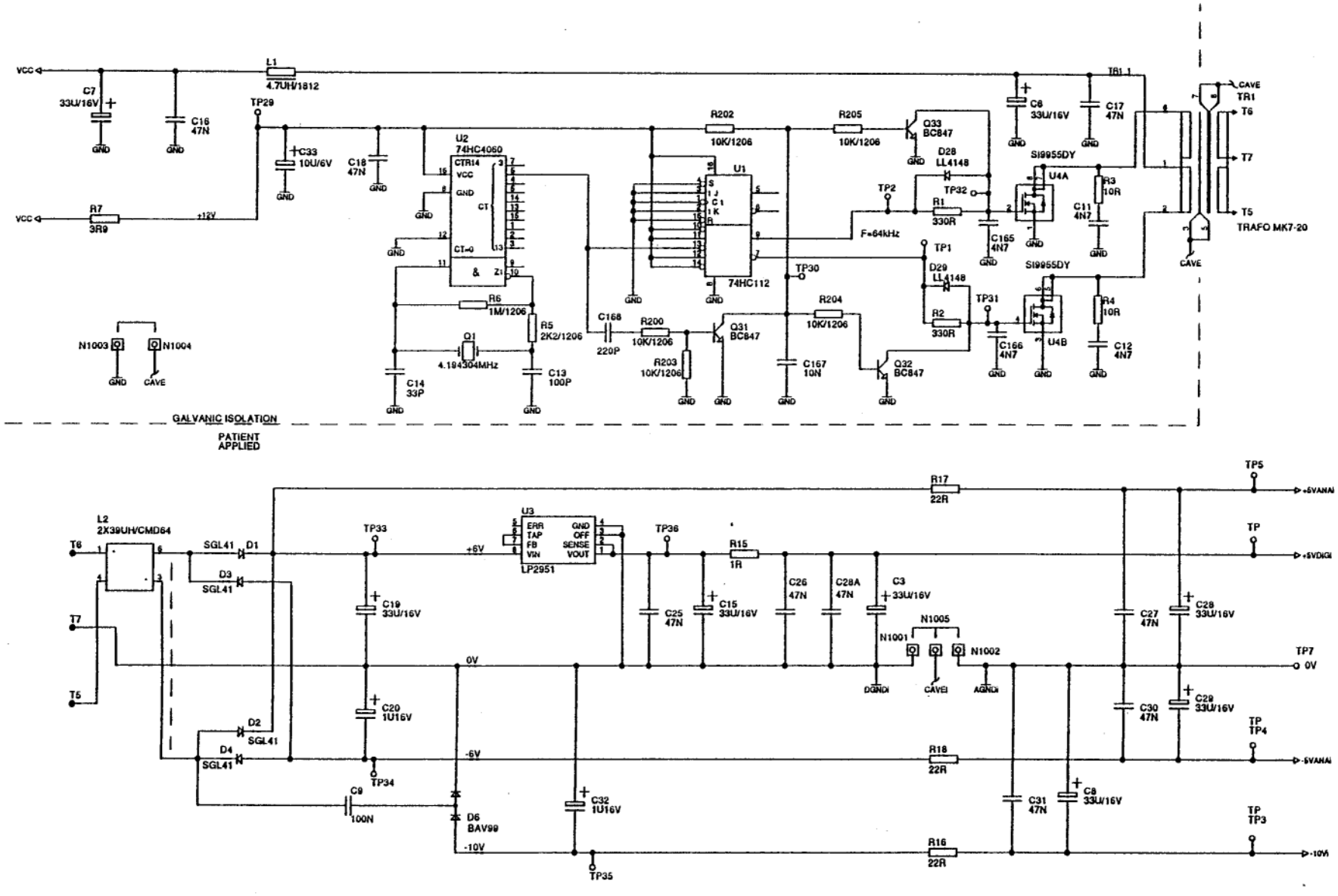
Date: October 7, 1993 Sheet 7 of 7

AT-60 Circuit Diagrams and Board Layouts

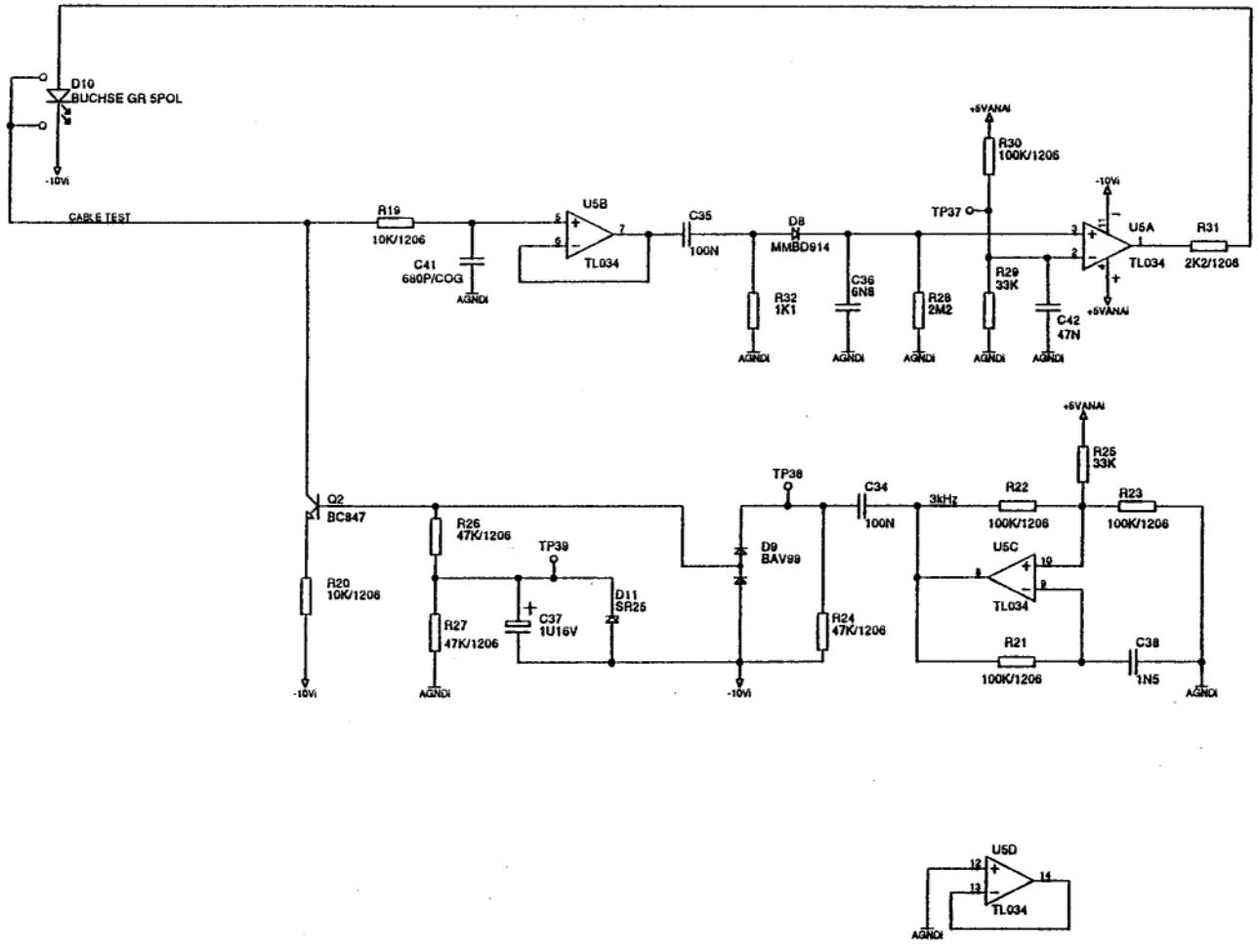
ECG Amplifier MK 7-20



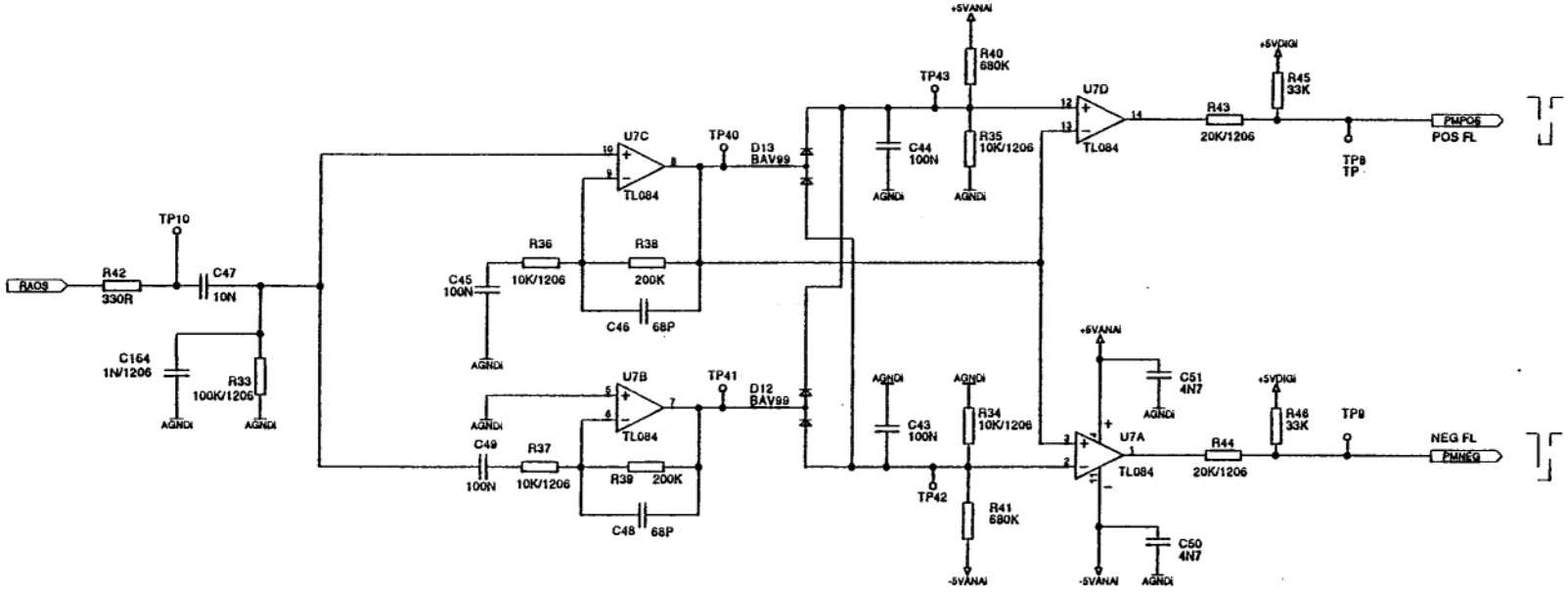
ECG INTERFACE MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 1 of 8	



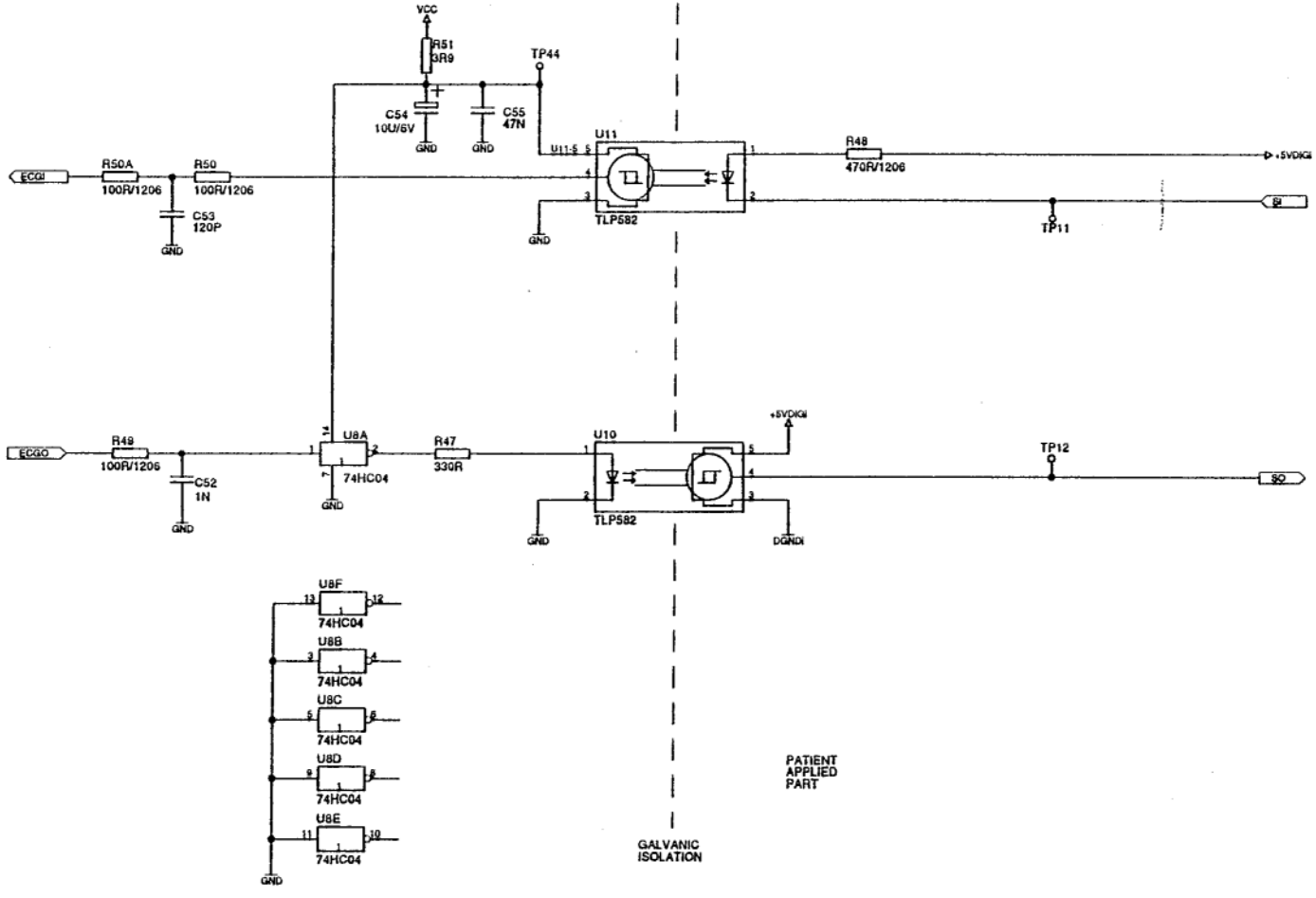
DC/DC CONVERTER MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 2 of 8	



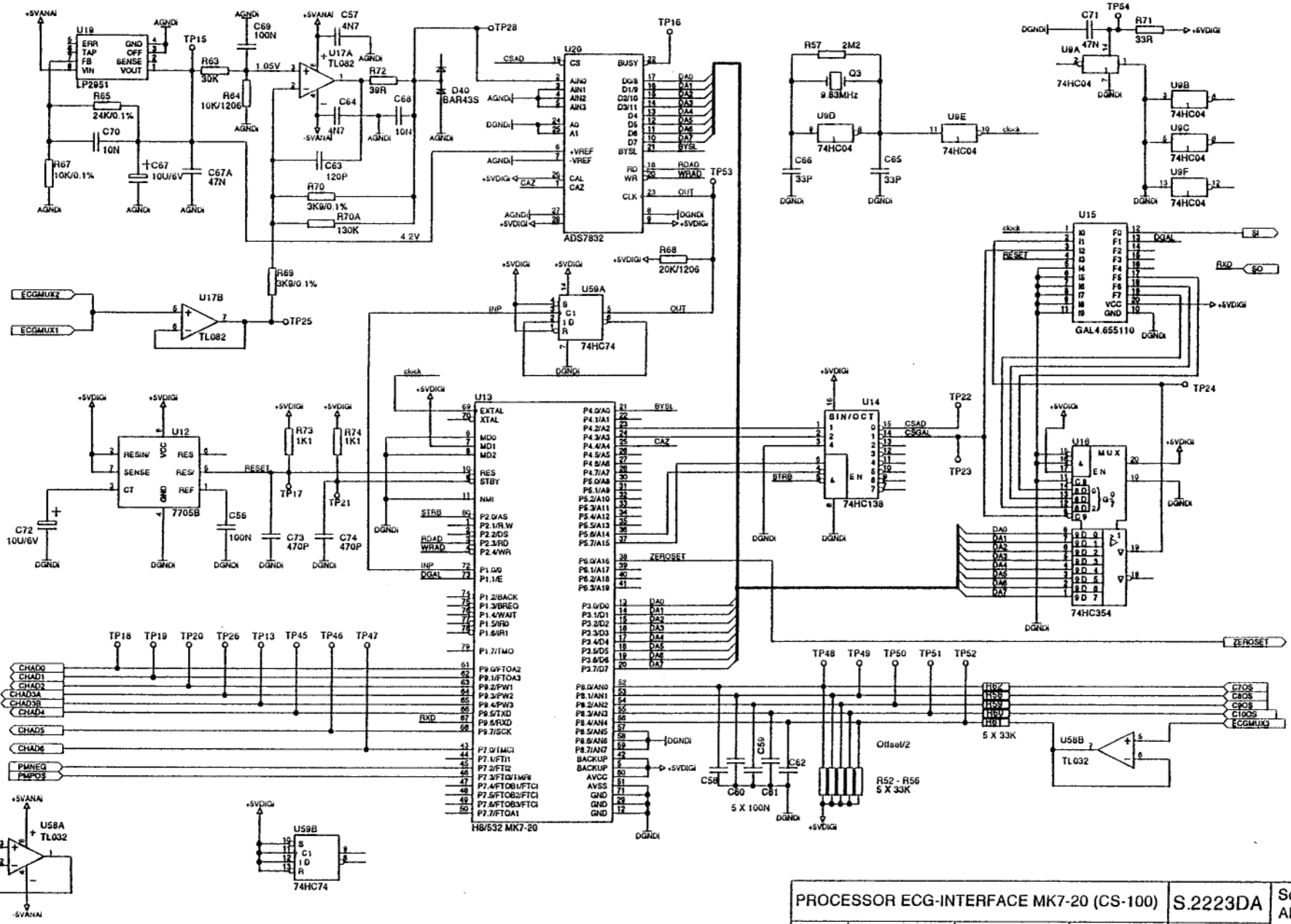
CABLE TESTER MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 3 of 8	



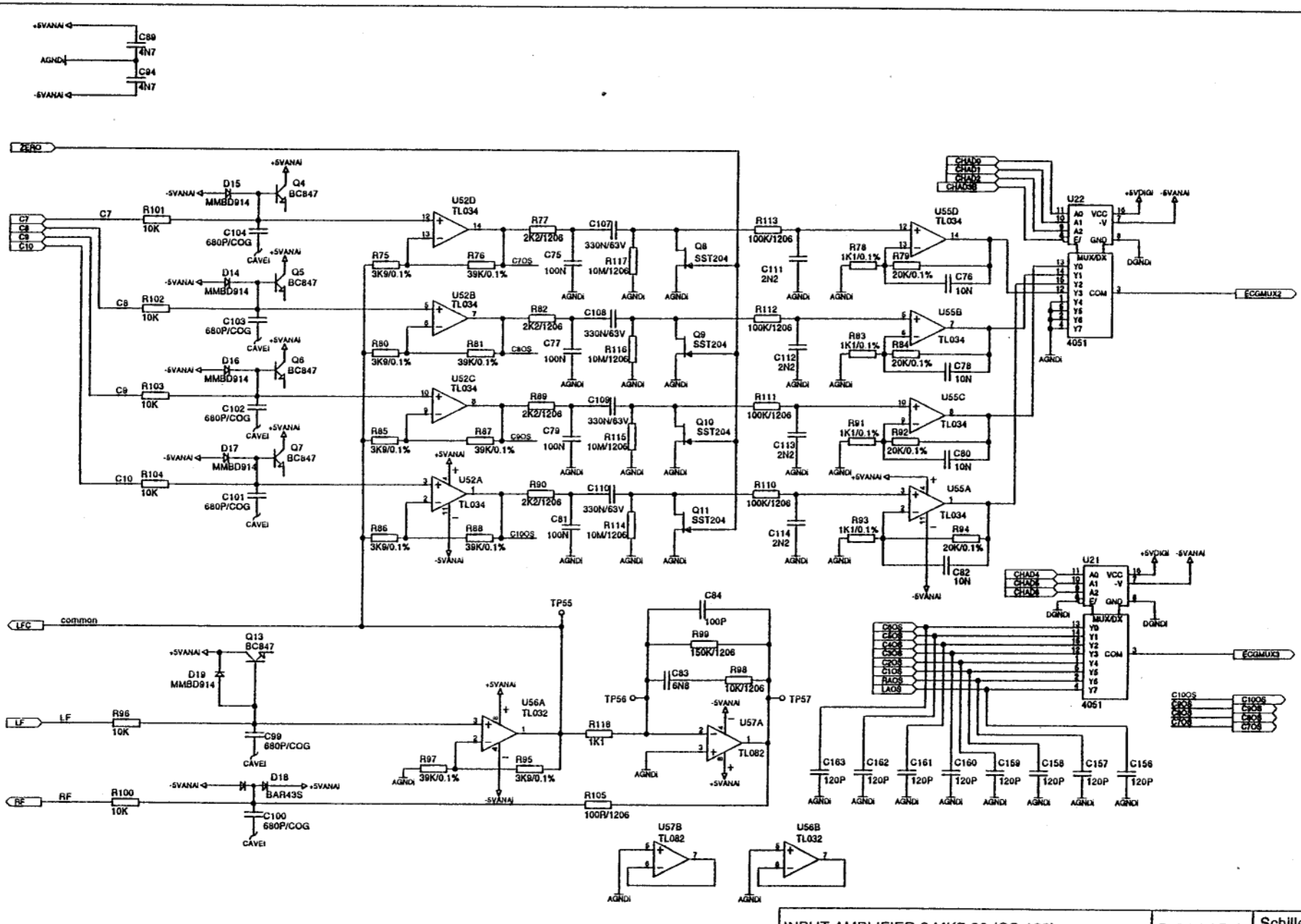
ECG PACEMAKER TRIGGER MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 4 of 8	

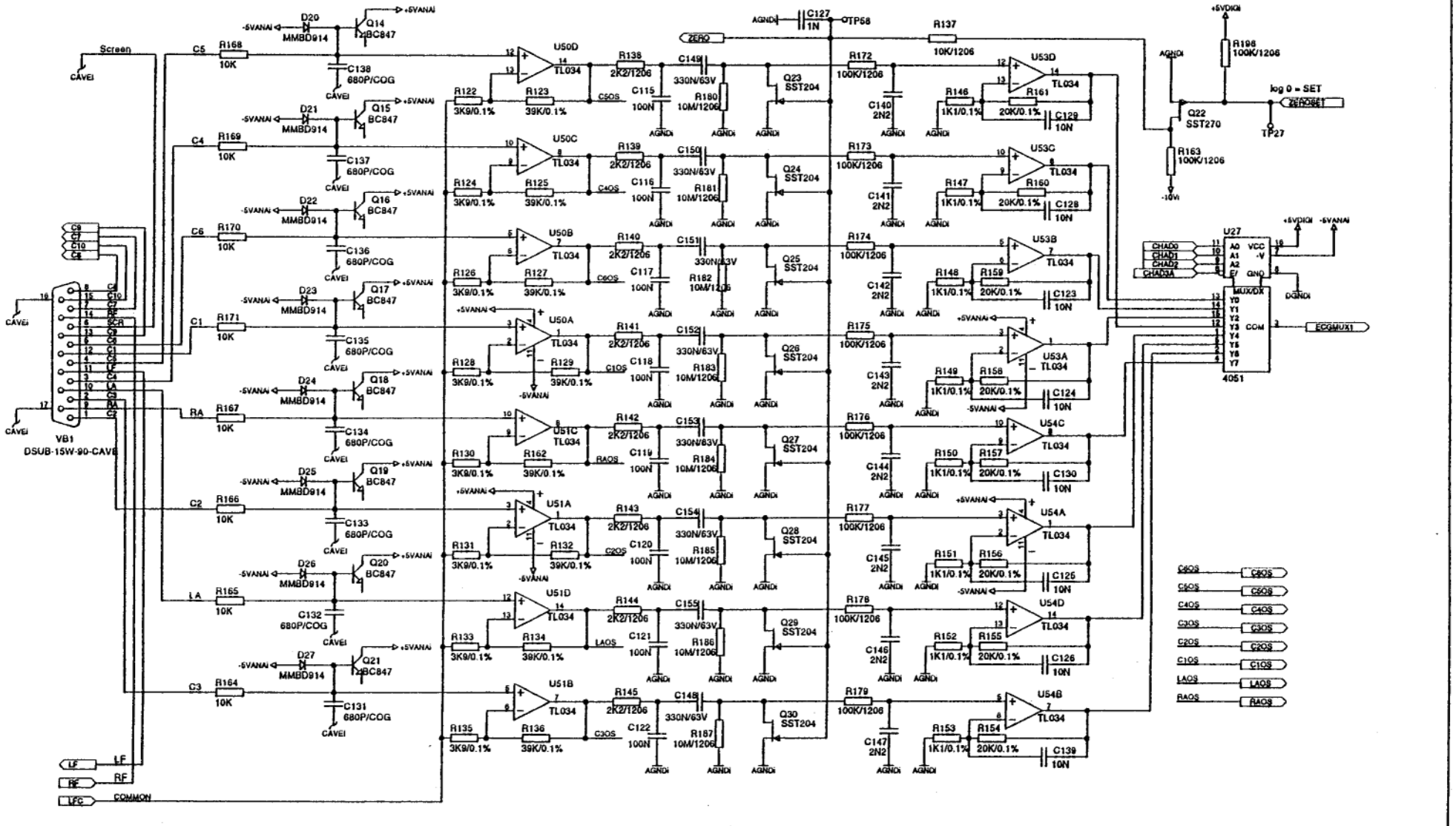


OPTOLINK MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 5 of 8	



PROCESSOR ECG-INTERFACE MK7-20 (CS-100)				S.2223DA	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: STR	Entw: HSCH	Date: 25.06.98	Sheet 6 of 8	

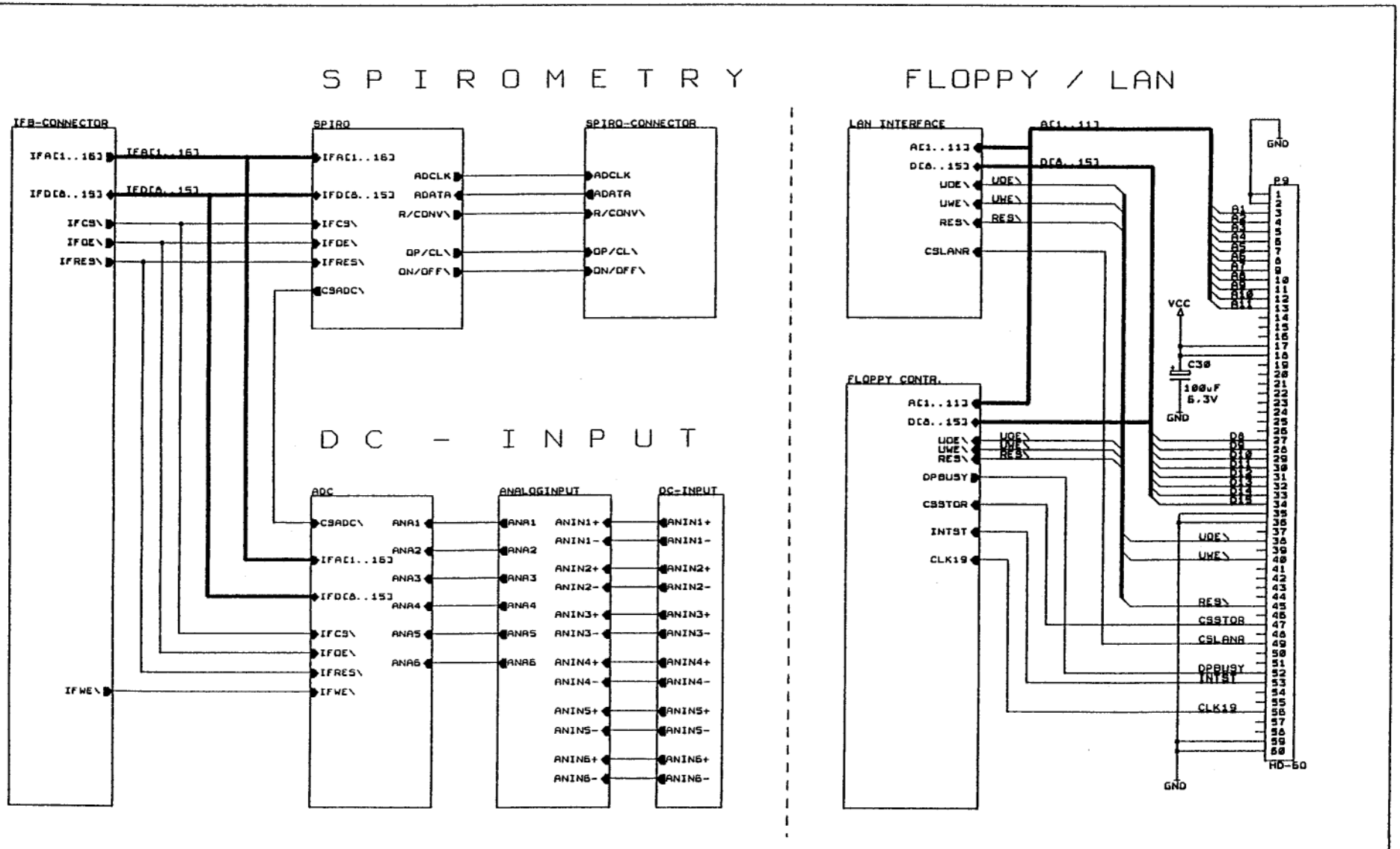

+5VANAI
C89
4N7
AGNDI
C94
4N7
-5VANAI
ZERO
C7
C8
C9
C10
R101
10K
R102
10K
R103
10K
R104
10K
C104
680P/COG
C103
680P/COG
C102
680P/COG
C101
680P/COG
CAVEI
D15
MMBD914
D14
MMBD914
D16
MMBD914
D17
MMBD914
Q4
BC847
Q5
BC847
Q6
BC847
Q7
BC847
U52D
TL034
U52B
TL034
U52C
TL034
U52A
TL034
R75
3K9/0.1%
R76
39K/0.1%
R80
3K9/0.1%
R81
39K/0.1%
R85
3K9/0.1%
R87
39K/0.1%
R86
3K9/0.1%
R88
39K/0.1%
R77
2K2/1206
R82
2K2/1206
R89
2K2/1206
R90
2K2/1206
C107
330N/63V
C108
330N/63V
C109
330N/63V
C110
330N/63V
C75
100N
C77
100N
C79
100N
C81
100N
R117
10M/1206
R116
10M/1206
R115
10M/1206
R114
10M/1206
C70S
C80S
C90S
C100S
Q8
SST204
Q9
SST204
Q10
SST204
Q11
SST204
R113
100K/1206
R112
100K/1206
R111
100K/1206
R110
100K/1206
C111
2N2
C112
2N2
C113
2N2
C114
2N2
U55D
TL034
U55B
TL034
U55C
TL034
U55A
TL034
R78
1K1/0.1%
R83
1K1/0.1%
R91
1K1/0.1%
R93
1K1/0.1%
R79
20K/0.1%
R84
20K/0.1%
R92
20K/0.1%
R94
20K/0.1%
C76
10N
C78
10N
C80
10N
C82
10N
CHAD0
CHAD1
CHAD2
CHAD3
U22
A0
A1
A2
E/
VCC
-V
GND
MUX/DX
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
COM
4051
+5VDIGI
-5VANAI
DGNDI
ECGMUX2
CHAD4
CHAD5
CHAD6
CHAD7
U21
4051
ECGMUX3
C100S
C90S
C80S
C70S
C163
C162
C161
C160
C159
C158
C157
C156
120P
LFC
common
LF
RF
Q13
BC847
D19
MMBD914
D18
BAR43S
R96
10K
R100
10K
C99
680P/COG
C100
680P/COG
TP55
TP56
TP57
C84
100P
R99
150K/1206
C83
6N8
R98
10K/1206
U56A
TL032
U57A
TL082
R97
39K/0.1%
R95
3K9/0.1%
R118
1K1
R105
100R/1206
U57B
TL082
U56B
TL032
INPUT AMPLIFIER 2 MK7-20 (CS-100)
S.2223DA
Schiller AG
Altgasse 68
CH-6340 Baar
Size: A3
Drawn by: STR
Entw: HSCH
Date: 25.06.98
Sheet 7 of 8

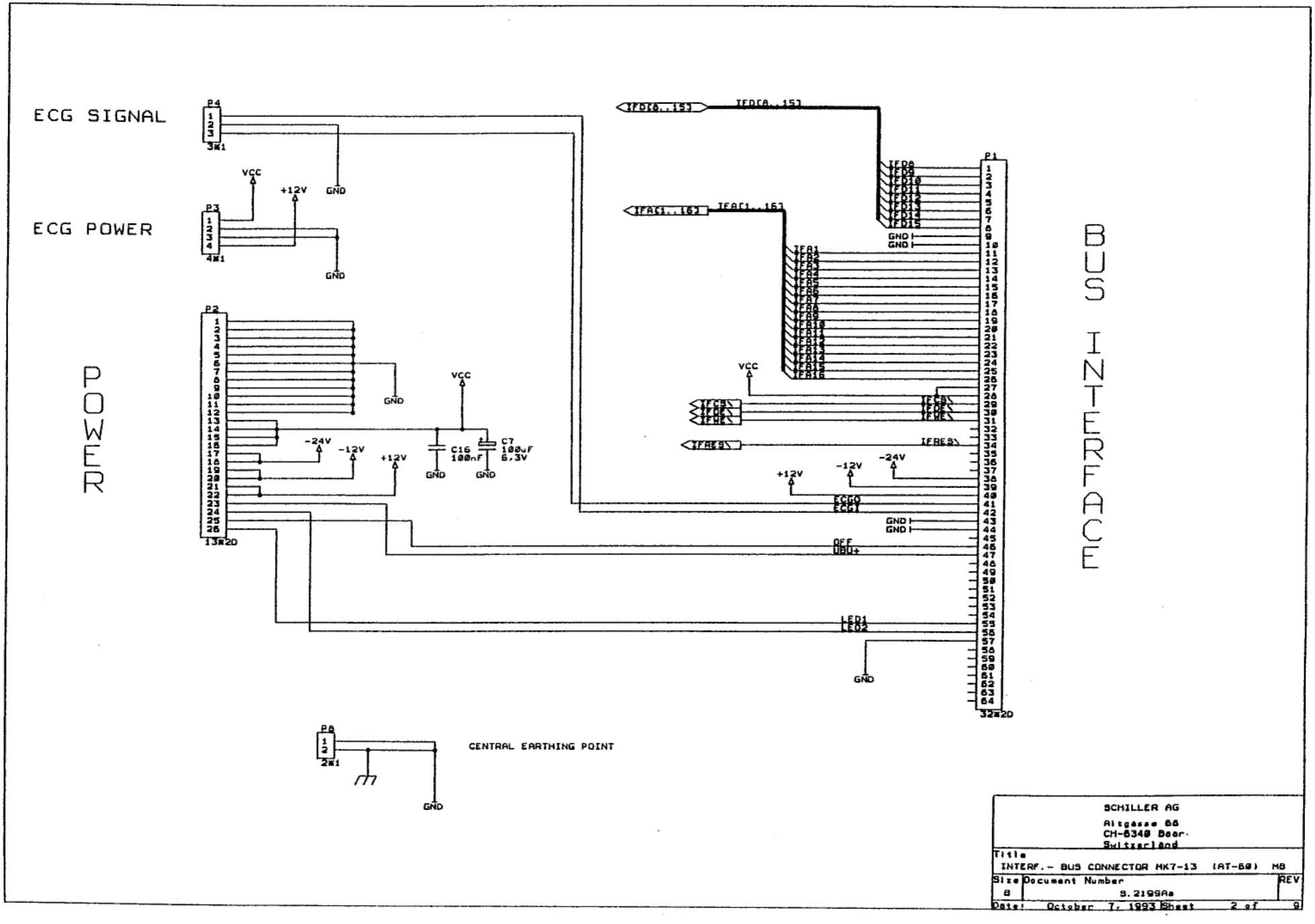

INPUT AMPLIFIER 1 MK7-20 (CS-100)
S.2223DA
Schiller AG
Altgasse 68
CH-6340 Baar
Size: A3
Drawn by: STR
Entw: HSCH
Date: 25.06.98
Sheet 8 of 8
VB1
DSUB-15W-90-CAVE
Screen
CAVEI
ZERO
TP58
TP27
Q22 SST270
log 0 = SET
RESET
U27
4051
MUX/DX
ECGMUX1
COMMON
LF
RF
LFC
RA
LA
C1
C2
C3
C4
C5
C6
U50A
U50B
U50C
U50D
U51A
U51B
U51C
U51D
U53A
U53B
U53C
U53D
U54A
U54B
U54C
U54D
TL034
SST204
MMBD914
BC847
C1OS
C2OS
C3OS
C4OS
C5OS
C6OS
LAOS
RAOS

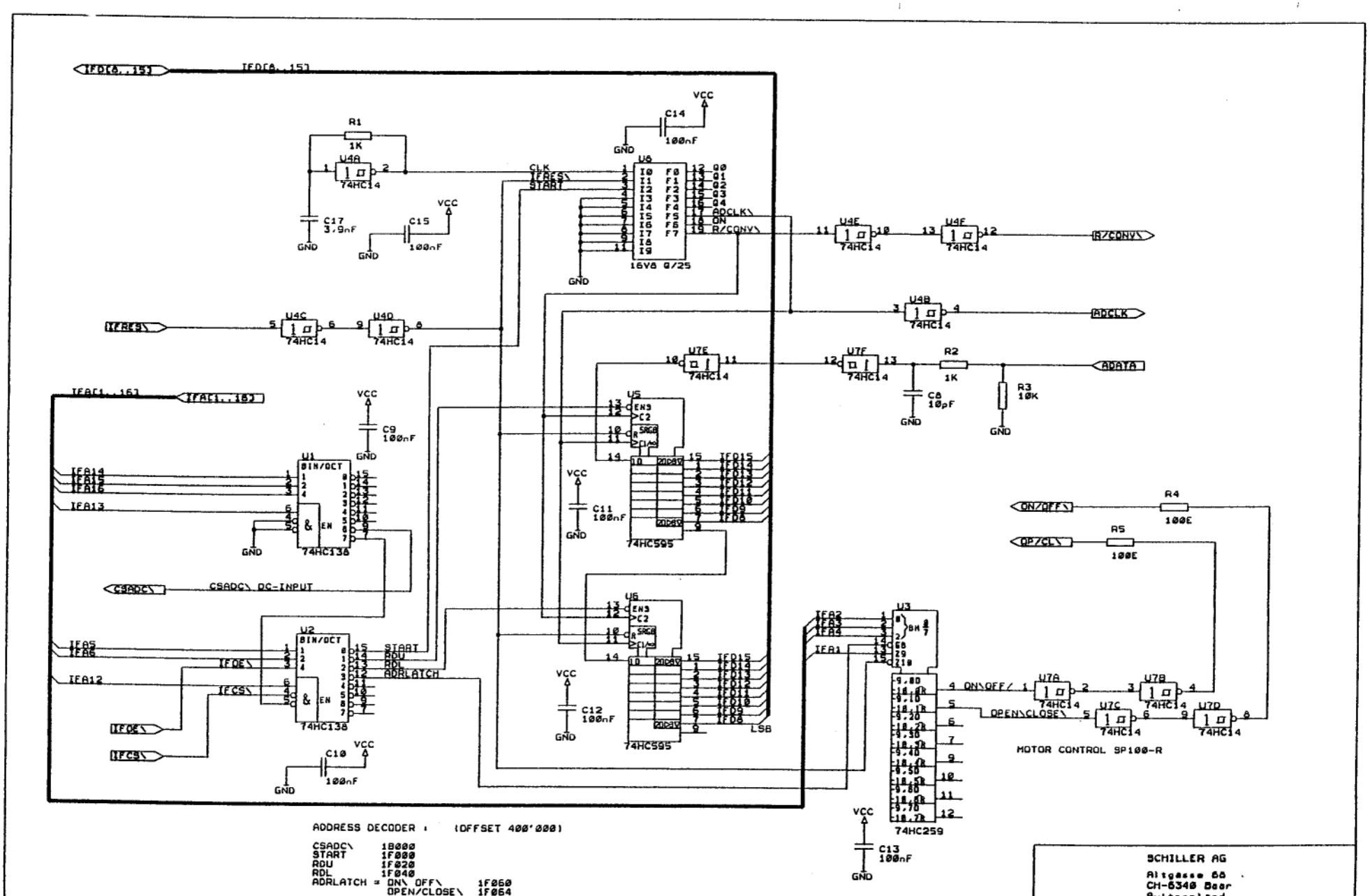
AT-60 Circuit Diagrams and Board Layouts

Microprocessor Expansion Board MK 7-13

& Calibration Switch MK 13-8


SPIROMETRY
IFB-CONNECTOR
IFAC1..16]
IFDC8..15]
IFCS\
IFOE\
IFRES\
IFWE\
SPIRO
IFAC1..16]
IFDC8..15]
IFCS\
IFOE\
IFRES\
CSADC\
ADCLK
ADATA
R/CONV\
OP/CL\
ON/OFF\
SPIRO-CONNECTOR
ADCLK
ADATA
R/CONV\
OP/CL\
ON/OFF\
DC - INPUT
ADC
CSADC\
IFAC1..16]
IFDC8..15]
IFCS\
IFOE\
IFRES\
IFWE\
ANA1
ANA2
ANA3
ANA4
ANA5
ANA6
ANALOGINPUT
ANA1
ANA2
ANA3
ANA4
ANA5
ANA6
ANIN1+
ANIN1-
ANIN2+
ANIN2-
ANIN3+
ANIN3-
ANIN4+
ANIN4-
ANIN5+
ANIN5-
ANIN6+
ANIN6-
DC-INPUT
ANIN1+
ANIN1-
ANIN2+
ANIN2-
ANIN3+
ANIN3-
ANIN4+
ANIN4-
ANIN5+
ANIN5-
ANIN6+
ANIN6-
FLOPPY / LAN
LAN INTERFACE
AC1..11]
DC8..15]
UDE\
UWE\
RES\
CSLANR
AC1..11]
GND
DC8..15]
UDE\
UWE\
RES\
P9
VCC
C30
100uF
6.3V
GND
FLOPPY CONTR.
AC1..11]
DC8..15]
UDE\
UWE\
RES\
DPBUSY
CSSTOR
INTST
CLK19
UDE\
UWE\
RES\
CSSTOR
CSLANR
DPBUSY
INTST
CLK19
GND
HD-50
SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland
Title
uP - EXPANSION BOARD MK7-13 (AT-80) HB
Size
B
Document Number
9.2199Aa
REV
Date: October 7, 1993 Sheet 1 of 9


ECG SIGNAL
ECG POWER
POWER
BUS INTERFACE
P4
3x1
P3
4x1
P2
13x2D
P1
32x2D
P8
2x1
VCC
+12V
GND
-24V
-12V
C16
100nF
C7
100uF
6,3V
IFD[0..15]
IFA[1..16]
IFRES\
OFF
UBO+
LED1
LED2
ECG0
ECG1
CENTRAL EARTHING POINT
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
INTERF. - BUS CONNECTOR MK7-13 (AT-60) MB
Size
B
Document Number
9.2199Ae
REV
Date: October 7, 1993 Sheet 2 of 9



ADDRESS DECODER : (OFFSET 400'000)

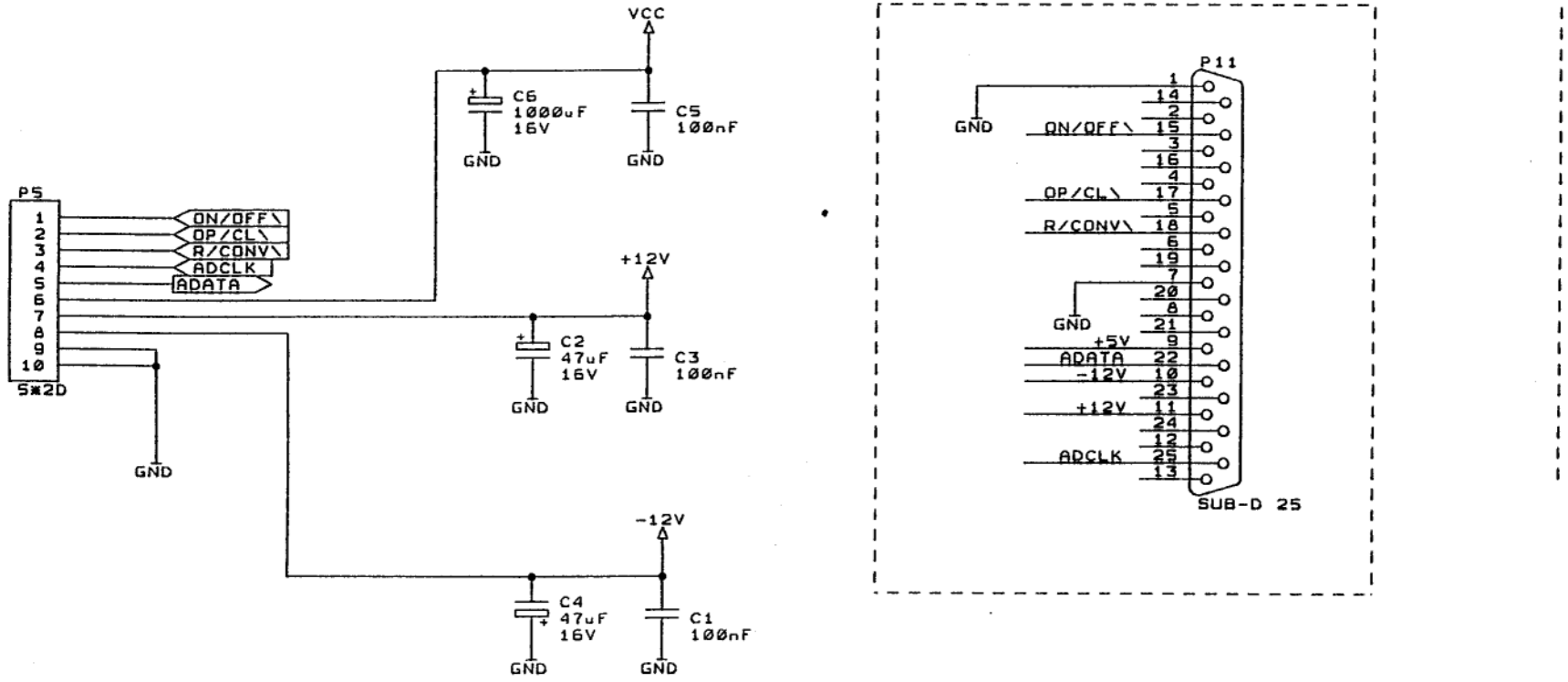
CSADC\	18000
START	1F000
RDU	1F020
RDL	1F040
ADRLATCH = ON\ OFF\	1F060
OPEN/CLOSE\	1F064

SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland

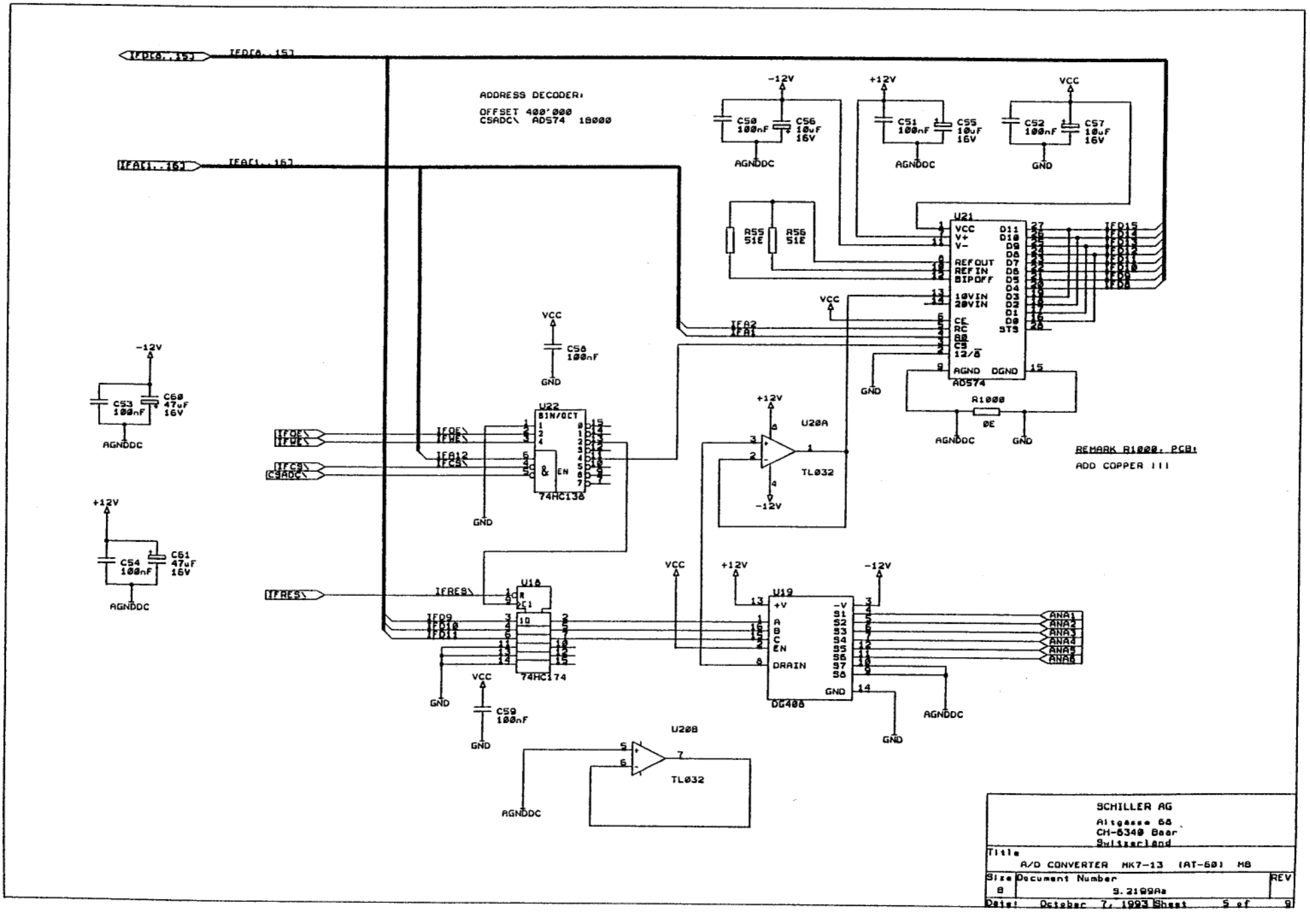
Title
INTERFACE SP100 / R MK7-13 (AT-60) MB

Size	Document Number	REV
B	5.2199Aa	

Date: October 7, 1993 Sheet 3 of 9



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		
Title CONNETOR SP100/R MK7-13 (AT-60) MB		
Size A	Document Number S.2199Aa	REV
Date: October 7, 1993	Sheet 4 of 9	

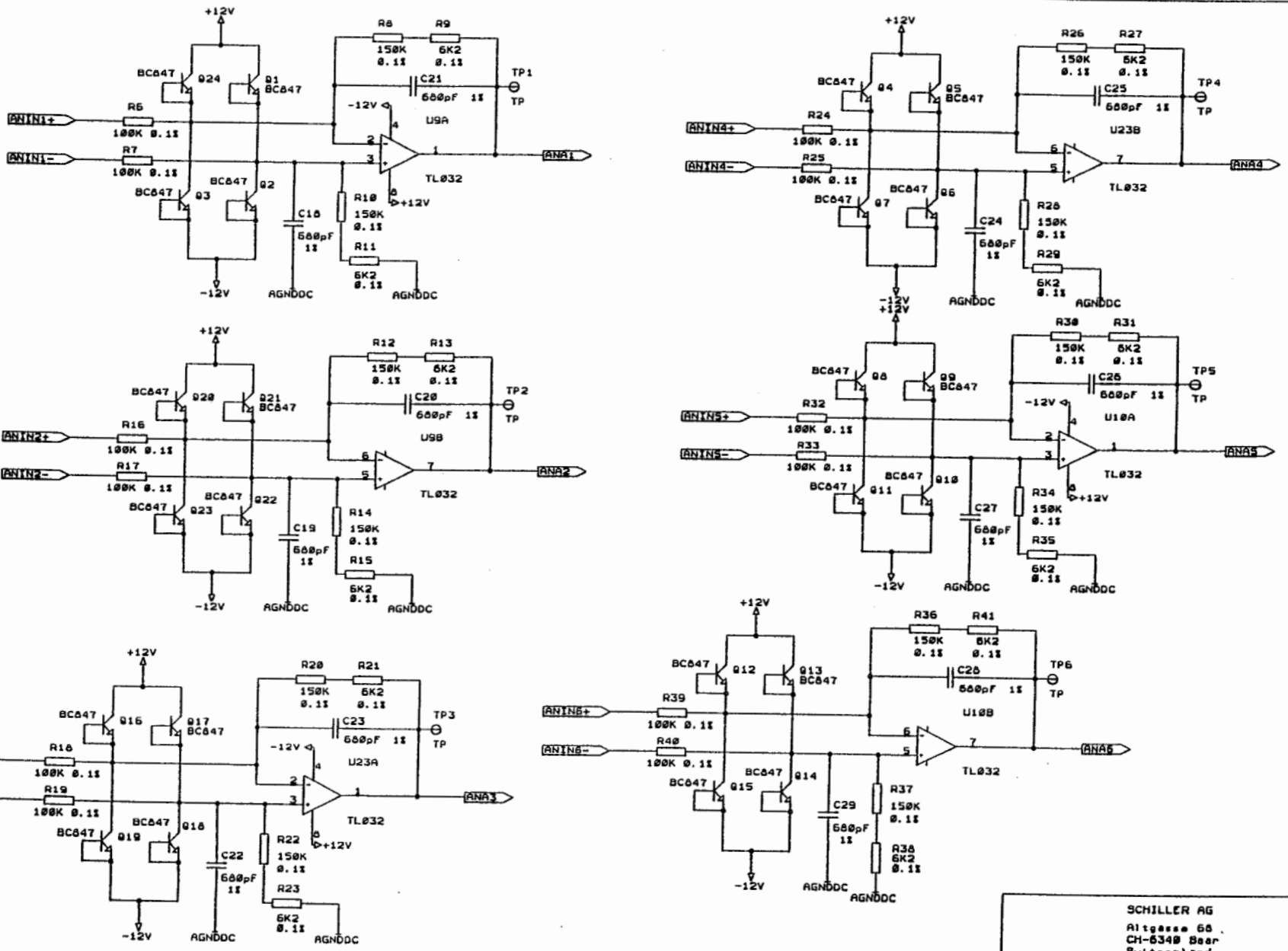


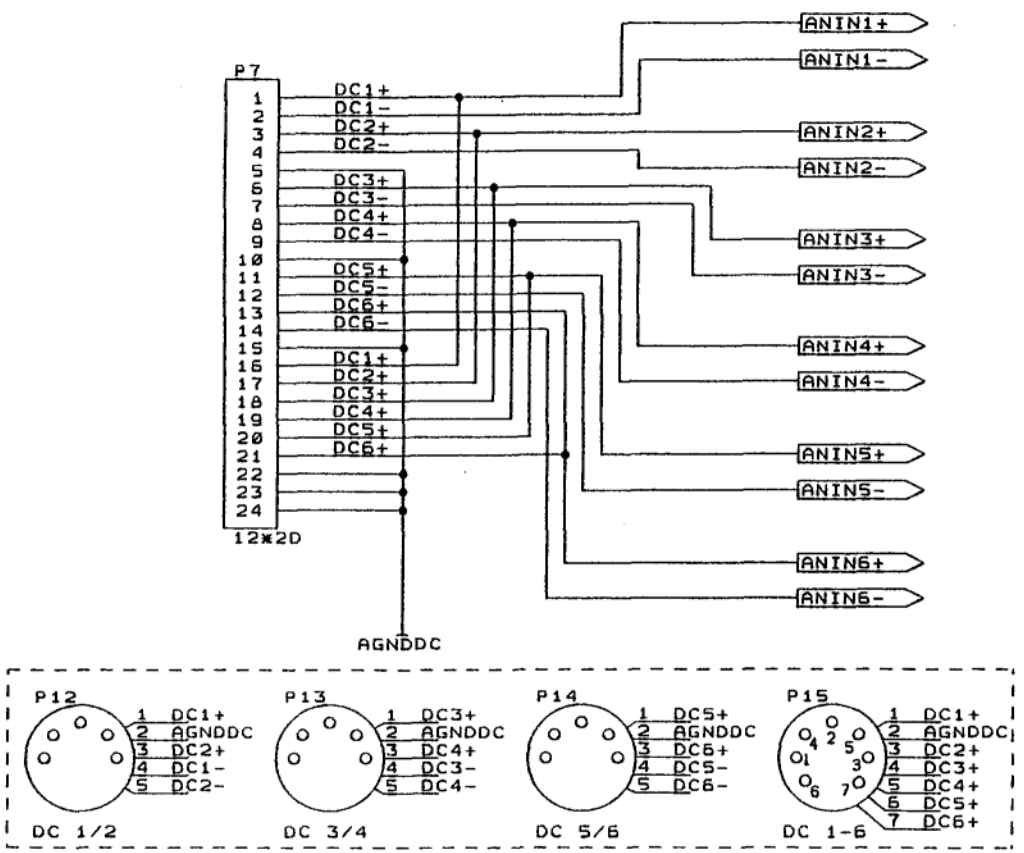
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland

Title
A/D CONVERTER MK7-13 (AT-60) MB

Size	Document Number	REV
B	9.2199As	

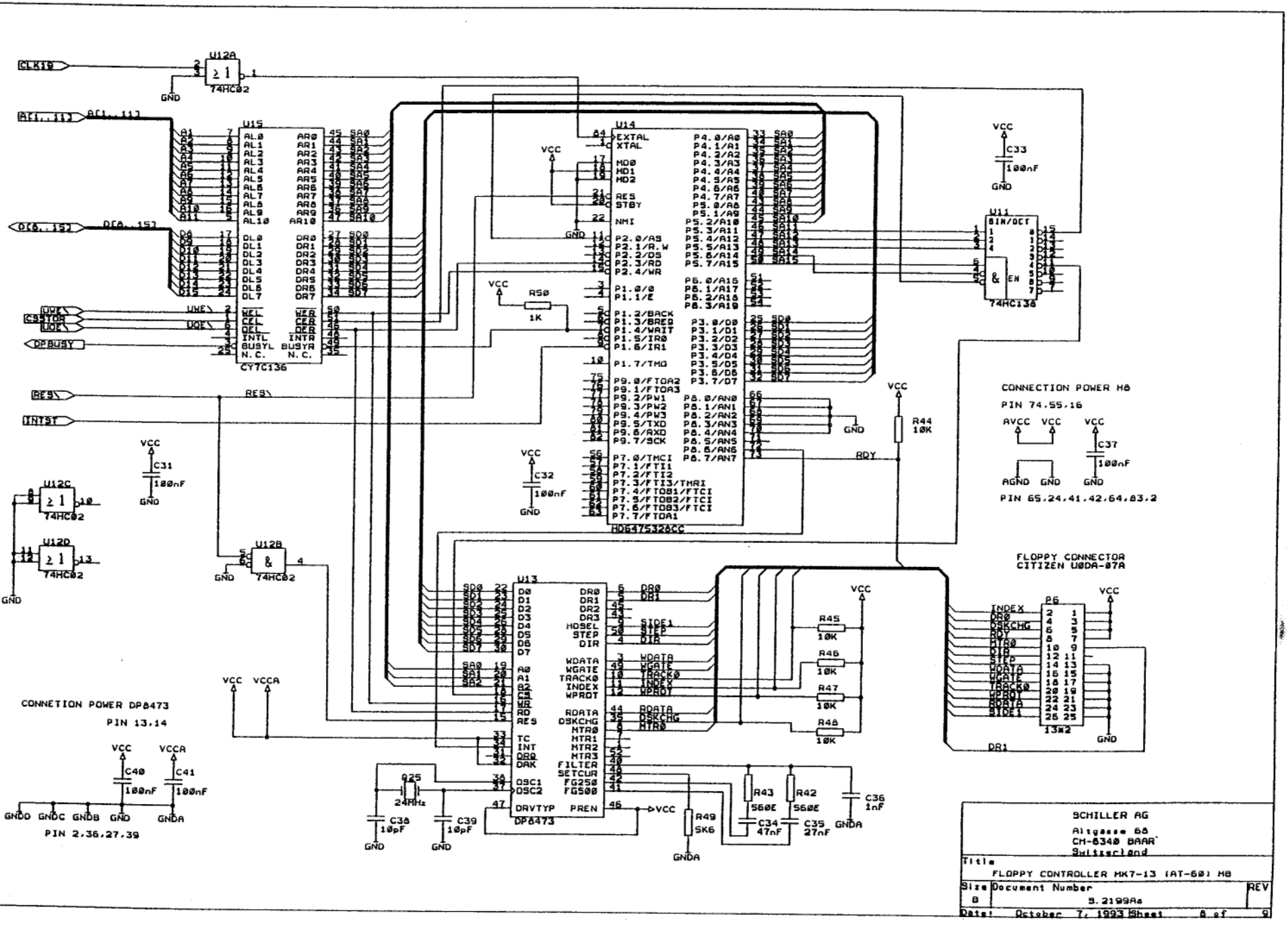
Date: October 7, 1993 Sheet 5 of 9

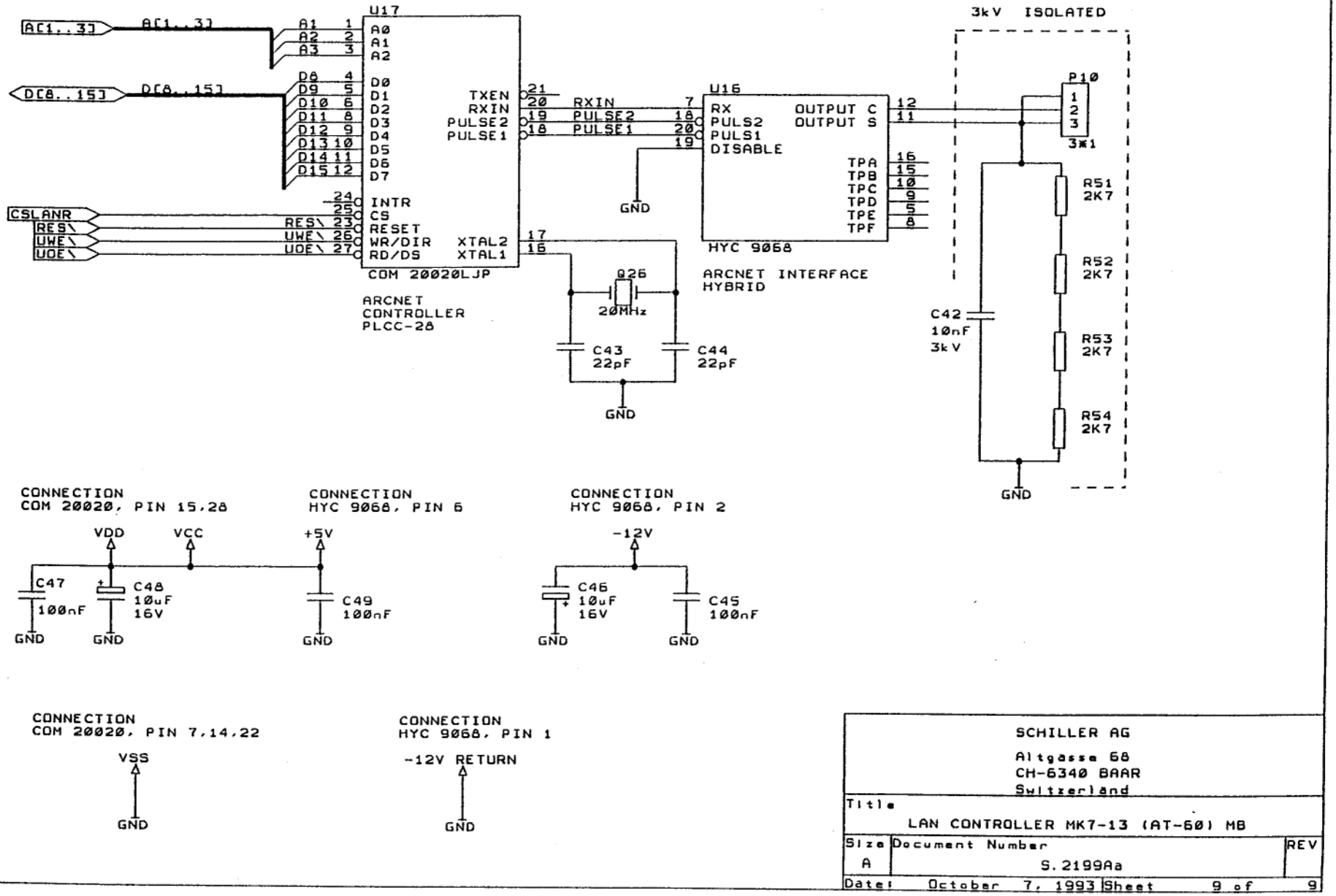

+12V
R8
R9
150K 0.1%
6K2 0.1%
BC847 Q24
Q1 BC847
C21 680pF 1%
TP1
TP
-12V
U9A
ANIN1+
R6 100K 0.1%
ANIN1-
R7 100K 0.1%
BC847 Q3
BC847 Q2
TL032
ANA1
C16 680pF 1%
R10 150K 0.1%
+12V
R11 6K2 0.1%
AGNDDC
R26
R27
C25 680pF 1%
TP4
U23B
ANIN4+
R24 100K 0.1%
ANIN4-
R25 100K 0.1%
BC847 Q7
BC847 Q6
ANA4
C24 680pF 1%
R28 150K 0.1%
R29 6K2 0.1%
R12
R13
C20 680pF 1%
TP2
U9B
ANIN2+
R16 100K 0.1%
ANIN2-
R17 100K 0.1%
BC847 Q23
BC847 Q22
ANA2
C19 680pF 1%
R14 150K 0.1%
R15 6K2 0.1%
R30
R31
C26 680pF 1%
TP5
U10A
ANIN5+
R32 100K 0.1%
ANIN5-
R33 100K 0.1%
BC847 Q11
BC847 Q10
ANA5
C27 680pF 1%
R34 150K 0.1%
R35 6K2 0.1%
R20
R21
C23 680pF 1%
TP3
U23A
ANIN3+
R18 100K 0.1%
ANIN3-
R19 100K 0.1%
BC847 Q19
BC847 Q18
ANA3
C22 680pF 1%
R22 150K 0.1%
R23 6K2 0.1%
R36
R41
C28 680pF 1%
TP6
U10B
ANIN6+
R39 100K 0.1%
ANIN6-
R40 100K 0.1%
BC847 Q15
BC847 Q14
ANA6
C29 680pF 1%
R37 150K 0.1%
R38 6K2 0.1%
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
DC - INPUT MK7-13 (AT-60) MB
Size B
Document Number
S.2199Aa
REV
Date: October 7, 1993 Sheet 6 of 9



FRONT VIEW

SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		
Title CONNECTOR DC-INPUT MK7-13 (AT-60) MB		
Size A	Document Number S.2199Aa	REV
Date: October 7, 1993	Sheet 7 of 9	


CLK16
U12A
74HC02
GND
A[1..11]
U15
CY7C136
D[0..15]
UWE\
CS\
UOE\
DPBUSY
RES\
INT5\
U14
HD6475328CC
VCC
C33
100nF
U11
8IN/DEF
74HC138
R50
1K
R44
10K
RDY
CONNECTION POWER H8
PIN 74.55.16
AVCC VCC VCC
C37
AGND GND GND
PIN 65.24.41.42.64.83.2
C31
C32
U12C
U12D
U12B
U13
DP8473
CONNETION POWER DP8473
PIN 13.14
VCCA
C40
C41
GNDD GNDC GNDB GND GNDA
PIN 2.36.27.39
Q25
24MHz
C38
10pF
C39
R45
R46
R47
R48
10K
FLOPPY CONNECTOR
CITIZEN U0DA-07A
P6
13x2
DR1
R43
560E
R42
C34
47nF
C35
27nF
C36
1nF
R49
SK6
SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland
Title
FLOPPY CONTROLLER MK7-13 (AT-60) H8
Size B
Document Number
5.2199As
REV
Date: October 7, 1993 Sheet 8 of 9

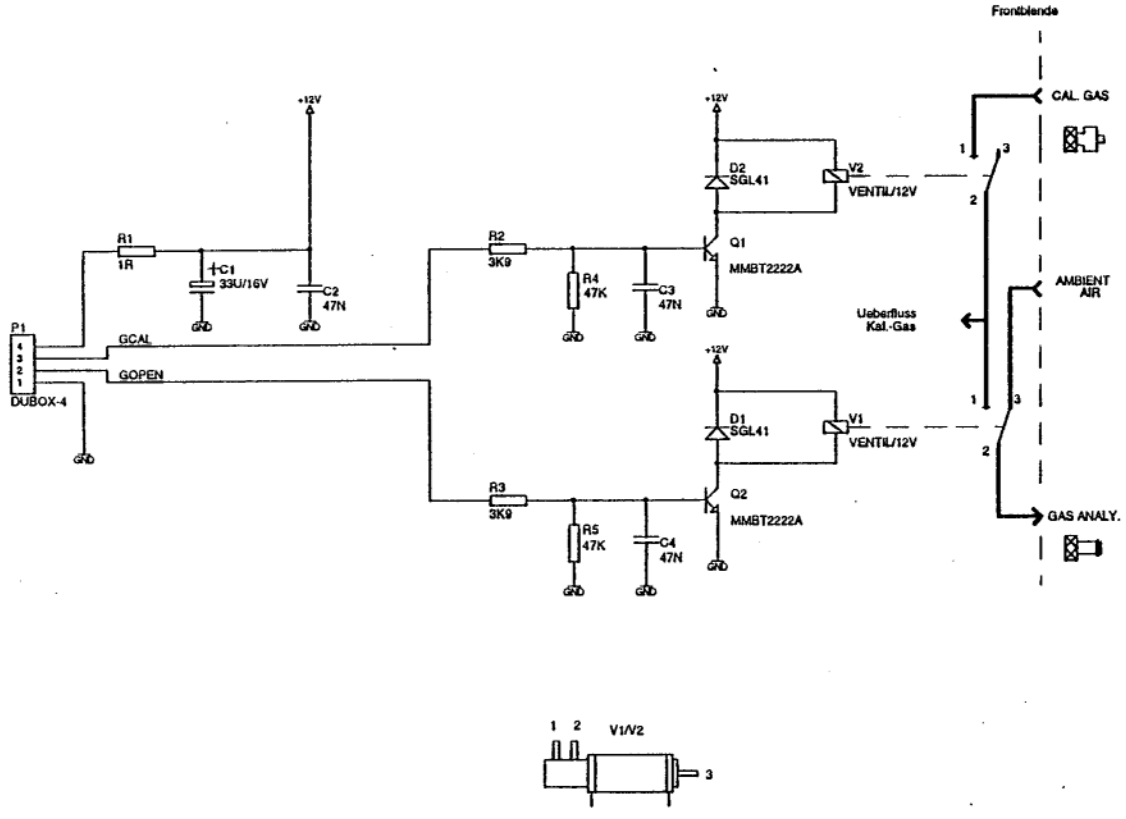


SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland

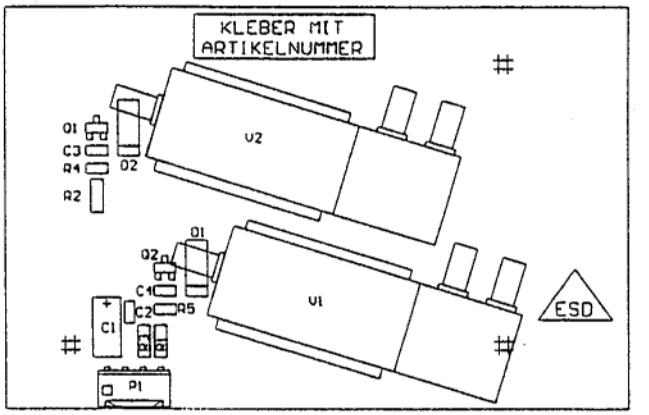
Title: LAN CONTROLLER MK7-13 (AT-60) MB

Size	Document Number	REV
A	S.2199Aa	

Date: October 7, 1993 Sheet 9 of 9



Title Calibration Switch MK13-8			(CS-200 AT-60)	Schiller AG Altgasse 68 CH-6340 Baar Switzerland
Size: A3	Nr: S.2456Aa	Revision:		
Drawn by: Gau		Date: 05.07.96	Sheet 1 of 1	



Title: CAUBRATIONS SWITCH MK13-8				D.2456Aa	Schiller AG Altgasse 68 CH-6340 Baar
Project: CS-200 AT-60					
Visum:	Drawn By: Gau	Entw.	Prod.	Date 24.07.96	Sheet 1 of 1